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DESIGN AND DEVELOPMENT OF THE SCENARIO FOR THE SECOND NPS A2C2 EXPERIMENT

by

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DESIGN AND DEVELOPMENT OF THE SCENARIO FOR THE SECOND NPS A2C2 EXPERIMENT

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ABSTRACT

The Adaptive Architectures for Command and Control (A2C2) project is a research effort sponsored by the Office of Naval Research to explore adaptation in joint command and control structures. The project's second experiment builds on the first experiment and studies the interaction between task structure and organizational structure. This thesis builds on the work of previous theses by Michael Berigan and Greg Higgins. It describes a process for developing military operational scenarios within a task structure context. First, the author conducts a literature review, which defines the dimensions of task structure applicable to this project, and describes how changes in one dimension might affect other dimensions. Then a method for developing scenarios in accordance with a predetermined structure and visualizing tasks is described, including a task structure diagram and a description of a task design process using the diagram and the dimensions previously delineated. The author then applies the task design process by developing two scenarios for the second NPS A2C2 experiment that differ across one dimension of task structure, *coordination requirements*. Finally, a description of the experiment is given, including discussion of operationalization of scenarios and organization structures, and lessons learned from the experiment with regard to scenario design.

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EXECUTIVE SUMMARY

The Adaptive Architectures for Command and Control (A2C2) project is a four-year research effort sponsored by the Office of Naval Research. It involves researchers at the Naval Postgraduate School (NPS), the University of Connecticut, Michigan State University, George Mason University, Alphatech Inc., Aptima Inc., and several other institutions. The research focuses on organizational adaptation in joint command and control organizations, exploring how, why, and when organizations adapt or should adapt their structures, what skills, training, and technology are required to support that adaptation, and developing computer aids to help custom design organization structures for specific missions. The project consists of field research, computer modeling, and a series of human-in-the-loop experiments.

The A2C2 project uses a multi-player real-time simulation environment capable of :

- Focusing on the dynamic execution of the combatant phases of the mission
- Allowing researchers to easily manipulate key task structure variables and available resources and organizational structures.

The approach taken combines analytical and empirical efforts to develop a model-test-model paradigm of experimentation with human teams. A first step in this process was to abstract "real world" problems in order to bring them into a controlled laboratory environment where we could control a large variety of experimental conditions while manipulating independent variables of interest in order to measure their effects on the dependent variable used to test the hypotheses of interest.

The first experiment, conducted at NPS in March 1996, served as a baseline and test-run of the DDD-III simulation. The second experiment built on the findings of the first to explore the interaction between task structure and organizational structure and drivers of adaptation in an organization. This thesis focuses on the objectives of the A2C2 project in general and the specific details of the second NPS experiment conducted 12 - 26 November 1996. Emphasis is on the resources, scenario, and tasks designed to support the experiment and hypotheses selected by the A2C2 research team.

To design the scenario for the second NPS A2C2 experiment, a visual representation of a task's structure was developed using the task structure diagram methodology developed by Michael Berigan in NPS experiment one.

A literature review which defines the dimensions of task structure applicable to this project *(uncertainty, time pressure, complexity, coordination requirements, magnitude, resources required, information required, task formalization,* and *dynamicity*) and describes the task structure diagram is provided in the second chapter.

Once the dimensions of task structure are defined and a grading scale developed, an explanation of a task structure diagram is given. Many dimensions of task structure are represented directly in this diagram; others can be inferred from it. The task structure diagram method allows experimenters to ensure a task accomplishes the objectives that have been set, provides a straightforward, visual method for comparing it with other

tasks, and describes a task to those outside the task design process.

The task design process is then used to describe the second NPS A2C2 experiment. The dimension of interest was determined by the definitions of dimensions of task structure given previously, initial A2C2 field research, and results from the first NPS A2C2 experiment. The task structure dimension of interest, *coordination requirements,* was selected as the independent variable and introduced at two levels: high internal coordination and high external coordination over shared resources. The scenario used for A2C2 field research and the first NPS experiment provides the foundation for the second experiment. The next step is to design the scenario tasks, develop an organizational structure and provide data to UCONN modelers as input to their model-based optimized organizational structure.

Designing the experiment, required resolution of several issues:

- How to measure performance of organizations in order to compare their performance when using different organizational structures to perform the same tasks. Two task structures were used to examine whether interactions between task and organizational structures exists.
- How to inject internal and external stimuli, that were essentially equivalent in terms of the task load to resource ratio, into the scenario to induce adaptation in the organizations. An internal stimuli is a change to resources or capabilities of the organization. An external stimuli is a change in the environment or mission.

Of interest in the second experiment, with regard to organizational structure, were the performance of the model-based and operational organization structures and the designs of those dynamically selected by the subjects during the planning sessions. This interest results in the following research questions:

1. Does the performance of the model-based design organization match the model's predictions of performance?

2. In the face of an internal "*trigger*", do teams adapt by changing architectures?

3. In the face of an external "*trigger*", do teams adapt by changing architecture?

4. Do organizations adapt their organizational structures based on changes in mission task and resources available?

5. Why and how do organizations adapt?

6. Are some organizations better able to accommodate changes to mission or resources without a drop in performance than others? Are some organizations more robust than others? If so, why?

7. Can the model-based organizational structures developed by the modelers at UCONN, based on task structure and available resources, perform as well or better than those developed using the current method of selecting organizational structures used by operational commanders, as measured by performance, resources utilization, mission accomplishment, and losses?

Finally, a description of the experiment, including setup, discussion of operationalization of the scenarios and organizational structures, training conducted with the subjects, conduct of the experiment itself, and lessons learned from the experiment

with regard to scenario design is provided. A brief overview of the preliminary findings from the data, summary of the thesis and future areas of research complete the paper.

I. INTRODUCTION

A. THE A2C2 PROGRAM

The Adaptive Architectures for Command and Control (A2C2) Project is a continuing effort to examine adaption in joint command and control organizations. Rapid advances in communications technology and computers have made real-time command and control (C2) possible. This revolution in C2 capability will soon provide decision makers (DMs) in a joint military organization with an unparalleled tactical and strategic picture of the battlefield. A current area of focus within the Department of Defense (DoD) is organization of the force. New, highly evolved organizational concepts are considered one of the "enablers of the revolution in military affairs" (Joint War fighting Center, 1995). The Joint Staff's C4I for the Warrior (C4IFTW) concept, Copernicus, Sea Dragon, and other service initiatives that reside within the overarching C4IFTW concept call for flattened command structures. These flattened command structures will allow U.S. forces to begin achieving more efficient use of enhanced sensor-to-shooter communications capabilities and dominant battle space knowledge. Decision makers (DMs) will have the ability to rapidly access all information available within the organization, monitor actions made by other DMs, and call upon a world-wide data base to aid in the combat decision process. This powerful, "omnipotent" capability has been dubbed "Global Awareness"(Joint War fighting Center, 1995).

Researchers at the Naval Postgraduate School, the University of Connecticut, George Mason University, Michigan State University, Alphatech Inc., and Aptima Inc.

have theorized that the most capable organizations will respond by adapting their structures and processes from traditional, rigid hierarchical organizational structures into more flexible, network-like architectures to take advantage of the opportunities presented by enhanced sensor-to-shooter communications capabilities and dominant battle space knowledge.

Current research involving adaptive architectures for joint C2 seeks to examine the interactions between mission requirements and organizational structure. The Office of Naval Research (ONR), in the summer of 1995, commissioned a four-year research effort into this far-reaching topic - the A2C2 project. This project is exploring the changes in task structure, mission, and resources that drive changes to organizational structure in the joint warfare environment, and how the joint organization should adapt.

The A2C2 project is a national joint effort by researchers from academia, (University of Connecticut (UCONN),George Mason University(GMU), Michigan State University (MSU)), government agencies (Naval Postgraduate School, (NPS)), industry research activities (Alphatech Inc., Aptima Inc.), and other institutions. The project's goals are to advance the state of knowledge regarding decision making performance in joint organizational settings, to better understand how, why, and when organizations adapt or should adapt to a changing environment, and if the changes result in improved organization performance, to develop the skills, training, and technology required to support that adaptation (Alphatech/UCONN/NPS, 1995, p. 2). The researchers will make use of organizational theory, organizational models, simulated combat experiments with military officers, and field observation with experienced operational commanders in an

iterative process to expand this body of knowledge. The A2C2 project is moving through several phases. In late 1995, the data collection process began with field research, visits to military organizations, participation in demonstrations and wargames, and a round of structured interviews with experienced commanders from all branches of the U.S. Armed Forces.

The purpose of the field research was to identify potential drivers of adaptation in joint operations, from the perspective of commanders experienced in joint operations, and to raise the specific issues that should be addressed in the project's later experiments. "Drivers of adaption" is a phrase used to describe changes in mission tasks, resources, technology, etc. that cause an organization to adjust its structure or functionality for improved performance.

After the field interviews, the A2C2 researchers began a series of experiments using war games and simulations of increasing complexity and fidelity. Each experiment builds upon the field research, insights gained from modeling, and previous experiments.

The approach taken combines analytical and empirical efforts in a model–test-model paradigm featuring experimentation with human teams. A first step in this process was to abstract "real world" problems in order to bring them into a controlled laboratory environment where a large variety of experimental conditions could be controlled while manipulating independent variables of interest in order to measure their effects on the dependent variable used to test the hypotheses of interest. In order to conduct the empirical research, the A2C2 project requires a multi-player real-time simulation environment capable of :

- Focusing on the dynamic execution of the combatant phases of the mission
- Allowing researchers to easily manipulate key task structure variables and available resources and organizational structures.

The Distributed Dynamic Decisionmaking (DDD-III) paradigm was used as the simulation environment for both the first and second NPS experiments. This third-generation simulation is an evolution of an earlier version developed by UCONN (DDD-II), which was used extensively to conduct empirical research from 1989 - 1995 involving "open-ocean" naval team (distributed) decisionmaking and coordination. (Higgins, 1996)

B. PURPOSE OF THE THESIS

This thesis will discuss the objectives of the A2C2 project in general and the specific details of the second NPS experiment conducted 12 - 26 November 1996. Emphasis is on the resources, scenario, and tasks designed to support the experimental design, goals, and hypotheses.

To make this thesis a stand-alone document, several chapters from Michael Berigan's thesis, which focused on the first A2C2 experiment, will be included to provide background information.

C. THESIS OUTLINE

This paper consists of seven chapters and two appendices.

- Chapter II is an overview and review of those portions of Michael Berigan's thesis on the first NPS experiment which are applicable to this paper.
- Chapter III develops the methodology used to design the scenario and provide the inputs needed by UCONN for generating the model-based organizational structure.
- Chapter IV uses the methodology developed by Berigan to develop the task structure, describes the scenario and the organizational structures, provides details of the processes used in developing the organizations, and gives an overview of the conduct of experiment two.
- Chapter V is an overview of preliminary findings from experiment two. The findings are beyond the designed scope of the thesis, but are included for completeness and closure in order to lay a foundation for the research plan for NPS experiment three in November 1997.
- Chapter VI details some modifications to the DDD simulation made for the second experiment, preliminary plans for additional improvements, and lessons learned.
- Chapter VII is a summary of the paper and areas of future research.
- Appendix A provides the operational orders and order modifications used for training and briefing the players and the quick reference sheets used

during the DDD-III runs.

- Appendix B provides the data collection forms and player questionnaires.

II. DEFINING DIMENSIONS OF INTEREST

A. INTRODUCTION

To determine which types of organizations function best with different classes of tasks it is necessary to develop an organized and disciplined method to differentiate between tasks and organizations to ensure they are different. To differentiate between tasks, they must be characterized. This can be accomplished by decomposing each task into the lower levels of its various dimensions. What are the dimensions of task structure? Little in the literature of organizational theory and behavioral decision theory explains or defines dimensions of task structure. Discussions of one or several aspects of task structure are common (Wood, 1986, Campbell, 1988, Malone and Crowston, 1994, Ben Zur and Breznitz, 1981, Davis et al., 1991, Evaristo et al., 1995), but none provided a comprehensive exposition of these dimensions as they pertain to the A2C2 experiments until Michael Berigan discussed them in his thesis in 1996. Since I relied on his work in this particular area, I will include the applicable portions of chapter II from his thesis here to provide the necessary background information.

B. LITERATURE REVIEW

The following pages are an excerpt from Michael Berigan's thesis. The work was the basis on which the tasks for the second experiment were designed.

> The literature on dimensions of task structure is mainly composed of articles and papers from technical journals. The works described below are the

most significant to date from the perspective of enumerating dimensions of task structure. Six articles are discussed: Wood (1986) and Campbell (1988) deal with complexity, Malone and Crowston (1994) consider coordination requirements, Ben Zur and Breznitz (1981) deal with time pressure, Evaristo et al. (1995) describe time pressure and uncertainty, and Davis et al. (1991) discuss task activities, time frame, task formalization, task ambiguity, task complexity (using Wood's (1986) definition), and task significance.

(1) Wood

Robert E. Wood, in his article, "Task Complexity: Definition of the Construct" (1986), first states that tasks contain three components: (1) the *product*, or what is produced by completing the task; (2) *acts*, or things that must be done in order to complete the task; and (3) *information cues*, or information that provides the stimulus for performance of a task, or is required for the task to be completed. He then defines task complexity in terms of these three task components, and decomposes task complexity into three different components: *component complexity, coordinative complexity,* and *dynamic complexity*, and discusses methods for quantifying each of the components.

(i) Component Complexity

Component complexity is a direct function of the number of distinct acts that must be completed in the performance of the task and the number of distinct information cues that must be processed in order to perform the acts. Wood gives the sum TC_1, the measure of component complexity, as the sum of information cues for all acts of all subtasks within the task. [Berigan, 1996)

In experiment two, the level of component complexity at the micro level remained approximately the same as in experiment one, a detailed description of the scenario for the second experiment is contained in Chapter IV. At the macro level, many more task items were inserted into the scenario to increase the workload of all the decision makers. The purpose was to place a premium on resource utilization either by reducing existing resources or increasing the required tasks.

(ii) Coordinative Complexity

Coordinative complexity, as defined by Wood, refers to the relationships between task inputs and task products. It describes the form and strength of the relationships between information cues, acts, and products, as well as the sequencing of inputs. Wood gives a number of different indices with which

> to attempt to measure coordinative complexity, most of which are a bit obscure and difficult to obtain, and I will not elaborate on them because of the space that would require. The most straightforward is the sum of all precedence relations between each act and all other acts in the task, which he denotes TC_2. [Berigan, 1996)

We significantly increased the level of coordinative complexity in experiment two; the capabilities of the various platforms were modified such that many different possible combinations could be used to accomplish a given task or operation, but in many instances more than one platform and/or decision maker would need to coordinate efforts to bring sufficient assets to bear.

> ***(1) Dynamic Complexity***
>
> Wood defines dynamic complexity as changes in the task environment which affect the relationships between task inputs and products. He measures this by summing the changes in TC_1 and TC_2 over discrete time periods, reduced by the change multiplied by a predictability coefficient for each time period, to arrive at a dynamic complexity figure denoted TC_3.
>
> ***(2) Total Complexity***
>
> To arrive at a figure for total complexity, Wood obtains a weighted sum of the TC_1, TC_2, and TC_3 totals. The specific weights, represented by coefficients, assigned to each sum would be situationally dependent, constrained by the requirement that TC_1 be more heavily weighted than TC_2, and TC_2 more heavily weighted than TC_3.
>
> **i. Campbell**
>
> Donald J. Campbell, in his article "Task Complexity: A Review and Analysis" (1988), took a different approach to defining complexity. He posited that task complexity is closely related to information, and that any task attributes that increase the load, diversity, or rate of change of information should be considered contributors to task complexity. He found four task characteristics that meet that criterion: the degree to which a task contains *multiple paths, multiple outcomes, conflicting interdependence among paths,* and *uncertain or probabilistic linkages*.
>
> ***(a) Multiple Paths***
>
> Increasing the number of possible ways to complete a given task

increases the complexity of the task. This is particularly true if the paths vary in their "goodness," that is, some paths more efficiently or effectively complete the task than others. Complexity is reduced if all paths presented are of equal goodness.

(b) Multiple Outcomes

Outcomes are the different results the performer of the task wants to achieve when the task is completed. The greater the number of different outcomes, the more complex the task.

(c) Conflicting Interdependence Among Paths

Campbell defines this as negative relationships among desired outcomes. If achieving one outcome conflicts with achieving another outcome, task complexity increases.

(d) Uncertain or Probabilistic Linkages

Campbell defines linkages as the connection between potential path activities and desired task outcomes. If there is difficulty determining these linkages, or the linkages have a probability of less than one, information processing requirements are increased significantly, and task complexity increases.

ii. Malone and Crowston

Thomas W. Malone and Kevin Crowston, in their paper "The Interdisciplinary Study of Coordination" (1994) define coordination as managing dependencies between activities. They defined four different types of dependencies that could need to be managed: .*shared resources, producer/consumer relationships, simultaneity constraints,* and *task/subtask relationships.*

(1) Managing Shared Resources

Whenever more than one actor or activity requires a limited resource, coordination is required to ensure that the resource is properly allocated among the actors or activities.

(2) Managing Producer/Consumer Relationships

A producer/consumer relationship is one in which one actor or activity produces something that is used by another actor or activity.

(3) Managing Simultaneity Constraints

Simultaneity constraints occur where more than one activity must be performed at the same time as another, or when one activity must be performed

at a specific time in relation to the performance of another activity.

(4) Managing Task/Subtask Relationships

Task/subtask relationships occur when a task must be broken up into multiple subtasks, and the subtasks divided up among multiple actors or different time periods for completion.

iii. Davis, Collins, Eierman, and Nance

Gordon Davis, Rosann Webb Collins, Michael Eierman, and William Nance, in their working paper "Conceptual Model for Research on Knowledge Work" (1991) discuss characteristics of task environment that apply to knowledge tasks rather than manual tasks. They came the closest, of any work with which I am familiar, of attempting to somewhat comprehensively enumerate dimensions of task structure, although I do not believe that their enumeration is complete, or that they even, in some cases, considered the right dimensions. However, some of the characteristics they describe are quite useful. They discuss six characteristics: task activities, time frame, task formalization, task ambiguity, task complexity, and task significance, of which formalization, ambiguity, and complexity are the most suitable for the purposes of this thesis.

(1) Task Activities

Davis et al. define task activities as the operations that must be implemented to complete a task, with each activity being associated with one or more problem spaces.

(2) Time Frame

The amount of time it will take to complete a task.

(3) Task Formalization

The authors consider task formalization to be the level of specification and structure that is imposed on the performance of the task, or task inputs or outputs. A task with high formalization would be described in a very structured way; there are certain well-defined activities that must be performed in a explicit order to complete the task. In a task with low formalization, though, the activities required to complete the task, and even the goals of the task, would be poorly defined and open to interpretation.

(4) Task Ambiguity

Task ambiguity is defined as the clarity of understanding of the activities that are required to complete a task, or of the inputs or outputs of a task.

(5) Task Complexity

The authors use Wood's (1986) definition of complexity.

(6) Task Significance

Task significance is defined as the value of the task output to the organization performing the task, and the interdependency between task outputs and other operations of the organization.

iv. Evaristo, Adams, and Curley

Roberto Evaristo, Carl Adams, and Shawn Curley, in their article "Information Load Revisited: A Theoretical Model" (1995) describe three task characteristics: time pressure, task formalization, and task complexity. The authors define time pressure as the time available to perform the task, and reiterate Davis et al.'s (1991) definition of task formalization and Wood's (1986) definition of task complexity. Their most interesting contribution is their description of uncertainty, although they do not consider it a task characteristic, but an information characteristic. They define uncertainty as knowledge inadequacy, resulting in an actor's inability to predict something accurately. They further cite the sources of uncertainty as unavailability or incompleteness of information, low information reliability, and information novelty.

v. Ben Zur and Breznitz

Hasida Ben Zur and Shlomo J. Breznitz, in their article "The Effect of Time Pressure on Risky Choice Behavior" (1981) define time pressure as the amount of information that must be considered and processed during one time unit, or as the time allotted for processing a fixed amount of information. Their definition refers to time pressure in the information domain, but it could be generalized to include the task domain as well. [Berigan, 1996)

C. DIMENSIONS OF TASK STRUCTURE

Dimensions of task structure are the characteristics which describe and identify a task. To define the dimensions of task structure that are of interest in the A2C2 experiment, nine dimensions are detailed: uncertainty, time pressure, complexity, coordination requirements, magnitude, resources required, information required, task formalization, and dynamicity. Ideally, these dimensions should be orthogonal, but complete orthogonality would require a comprehensiveness that is beyond the scope of the experiment at this phase in the A2C2

project. As a result, there are some interactions between dimensions. For each dimension of task structure, a definition and an example in an operational military context are given, followed by a description of how any given task could be graded in that dimension.

vi. Uncertainty

(1) Definition

Uncertainty is defined as the degree to which information about states, inputs, outcomes, or environments of tasks is unknown (Evaristo, et al., p. 200).

(2) Levels

This dimension is difficult to quantify, and grading must be done on a subjective basis. There are a number of ways to subjectively grade dimensions, which will be used throughout this chapter. First, anchored scales can be used. Anchored scales are scales of measurement (from 0 to 100, for example) in which illustrations are given of a task that would be graded ("anchored") at various points on the scale, typically the high and the low ends. For example, if "uncertainty" was graded using an anchored scale, an event of which absolutely no information about states, inputs, outcomes, or environments was known would be considered a "0," and an event about which all information about states, inputs, outcomes, or environments was known would be considered a "100." The benefit of an anchored scale is that it allows for a moderate amount of transportability, that is, tasks that are not necessarily being evaluated in terms of one another and are otherwise dissimilar can be compared using a well-anchored scale. Another option for subjectively grading dimensions is to use a scale such as High, Medium, Low, and None. This scale would be adequate in circumstances where the only comparison of tasks that is of interest is between two or more tasks that are generally being evaluated in terms of one another, and are otherwise similar. Grading using this scale is rather arbitrary, depending on the grader's definition of the level, so its transportability is low.

(3) Example

A simple example of uncertainty would involve an AWACS operator dealing with unknown air tracks. Since the identification and intentions of the aircraft are not known (incomplete information on states, inputs, and environments), the AWACS operator is unsure whether to direct that the aircraft be shot down, warn it away, or let it continue what it is doing (incomplete information on outcomes). This task would be graded as Medium or High

uncertainty.

vii. Time Pressure

(1) Definition

Time pressure is the amount of activity that must be completed within a given amount of time (Ben Zur and Breznitz, 1981, p. 89). Alternately, it could be defined as the degree to which an individual or group performing a task are stressed by the requirement to complete the task within a given amount of time. I chose time pressure as a dimension rather than Davis et al.'s (1991) task characteristic "time frame," because time frame does not take into account the magnitude of the task at hand, while time pressure, being measured as a rate, does.

(2) Levels

Time pressure could be either represented using a subjective scale, such as High, Medium, Low, or None, or an anchored scale, or a more objective, quantitative scale, depending on the variation of the above definition that is being used. A subjective scale would suggest itself if comparing two or more dissimilar tasks, and the only information the researcher is interested in is whether there is time pressure on the task performer to complete the task within a certain period of time, and what the relative levels between the two or more tasks are. A quantitative scale would suggest itself when comparing tasks which are similar in most dimensions. Time pressure could then be represented as the number of activities or subtasks that must be completed, divided by the time available to complete the task. This method, unfortunately, requires a standard definition of activity or subtask, both in magnitude and duration. If two tasks are equal in the quantitative measure of time pressure described above, but one task's subtasks or activities take significantly longer to perform than the other task's, then the quantitative scale is inappropriate. In situations where the grader cannot with confidence equate the subtasks or activities of one task with those of another, time pressure should be graded using the subjective scale.

(3) Example

An example of time pressure from the Persian Gulf conflict is a mobile SCUD missile launcher, spotted setting up and preparing to fire. The identification information must be passed from the sensor to a control agency with the assets on hand to destroy the launcher, an asset must be assigned to destroy the launcher, the asset must travel to the launcher, and the asset must destroy the launcher, all in a matter of a few minutes[1]. This task has High time pressure, on a subjective scale. On an objective scale, if identifying, passing information,

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[1] This was rarely, if ever, successfully done during the Persian Gulf conflict.

assigning an asset, getting in position to attack, and attacking are all considered subtasks, and the time available is 10 minutes, then time pressure is 5/10 or 0.5 subtasks per minute.

viii. Complexity

I chose a variation on Campbell's (1988) definition of complexity over Wood's (1986), for several reasons. First, Campbell's four characteristics of complexity are more easily understood than Wood's three components of complexity, and are more simply measurable. Second, Wood's description of coordinative complexity is very close to Malone and Crowston's (1994) definition of coordination, which I chose to include as a separate dimension listed in paragraph four below. Finally, Wood's concept of dynamic complexity can (be) generalized to all dimensions of task structure, not just complexity, and it is included as dynamicity, in paragraph nine below.

Complexity, then, can be defined as the degree to which a task contains five task characteristics: multiple attributes, multiple paths, multiple outcomes, conflicting interdependence among outcomes, and uncertain or probabilistic linkages (Campbell, 1988, p. 43). Multiple attributes has been added to Campbell's original list of four characteristics on the basis of other articles. Specific definitions of the five task characteristics are as follows:

(1) Multiple Attributes

(a) Definition. The number of attributes that a task performer must take into account, or more than one thing that must be taken into consideration in order to complete the task, directly affect task complexity. The more attributes a task has, the more complex it is.

(b) Levels. Multiple attributes is graded by the number of attributes that must be taken into consideration.

(2) Multiple Paths

(a) Definition. The number of paths that could be taken to arrive at a desired outcome (Campbell, 1988, p. 43).

(b) Levels. This aspect of complexity is graded by the approximate number of paths that could be taken to arrive at the desired end state. In many cases, this number could be infinite, or approach infinity. When this is true, the evaluator should only count the major variations of paths.

(3) Multiple Outcomes

(a) Definition. The number of outcomes desired from a task. These outcomes need not be mutually exclusive (Campbell, 1988, p. 43).

(b) Levels. This aspect is graded by the number of different outcomes that the task performer needs to achieve.

(4) Conflicting Interdependence Among Outcomes

(a) Definition. Conflicting interdependence among outcomes is a negative relationship between desired outcomes. If achieving one desired outcome conflicts with achieving another desired outcome, complexity increases (Campbell, 1988, p. 44).

(b) Levels. Conflicting interdependence among outcomes can be graded by counting the number of conflicts between instances of subparagraph (c) above. Each conflict should then be given a grade of 1 if the conflict is minor, 2 if it is moderate, and 3 if it is severe, or some similar scale. These grades should then be totaled across all conflicts so that each task has a single, numerical grade.

(5) Uncertain or Probabilistic Linkages

(a) Definition. The condition where the connection between the potential path activities and the desired outcomes from a task are uncertain, or probabilistic (Campbell, 1988, p. 45).

(b) Levels. High, Medium, Low, or None.

(6) Example

A good general example of complexity is the conduct of an amphibious assault. The amphibious assault task contains *multiple attributes* (terrain, hydrography, enemy positions, roads, beaches, enemy reinforcement capability, etc.) One desired outcome of the task is to destroy or suppress enemy positions at or near the beachhead. There are several ways to do this (*MULTIPLE PATHS*), such as to use close air support, naval gunfire, infiltrate SEAL or reconnaissance teams, or some combination. There are also many additional outcomes (*MULTIPLE OUTCOMES*) that are desired, such as to achieve surprise and minimize casualties. However, achieving surprise and destroying and suppressing enemy positions are usually mutually exclusive (*CONFLICTING INTERDEPENDENCE AMONG PATHS*) — if the commander precedes his amphibious assault with a heavy air and sea bombardment, he will stand a good chance of destroying or suppressing the enemy positions, but he will probably destroy the element of surprise. Finally, if the enemy's positions at or near the beach are well protected and disguised, the commander is uncertain whether his possible actions of close air support, naval surface fire support, etc. will be able to successfully achieve his desired outcome of suppressing or destroying the enemy positions (*UNCERTAIN OR PROBABILISTIC LINKAGES*).

This example would be graded as follows:

(a) Multiple Attributes: The task attributes that must be considered in an amphibious assault are objective, time available, terrain, weather, hydrography, friendly forces available, enemy positions, enemy reinforcements, enemy air threat, enemy sea threat, enemy anti-air threat, beaches, mobility on land, and non-combatants, for a total of 14. These are very high-level attributes, so it would be inappropriate to compare this task with a task in which the attributes were low-level.

(b) Multiple Paths: The number of paths that could be taken to conduct an amphibious assault is infinite. They can be categorized into major variations, however. The major paths that could be taken are to conduct the assault (as an across-the-beach assault, vertical envelopment, or combination) with extensive air and naval surface fire support beach preparation, conduct the assault without extensive air and naval surface fire support beach preparation, conduct the assault while destroying/suppressing enemy positions using stealthy means (SEAL/Recon teams/Information Warfare), or any of the three previously mentioned paths, plus a feint at a different location, for a total of 6 possible major paths.

(c) Multiple Outcomes: High-level desired outcomes for the given amphibious assault task are to (a) accomplish the objective, (b) achieve surprise, (c) suppress enemy positions at the beach, (d) minimize casualties, (e) interdict enemy reserves, (f) achieve sea supremacy, (g) achieve air superiority, and (h) minimize collateral damage, for a total of 8 desired outcomes.

(d) Conflicting Interdependence Among Outcomes: Conflicts, and the scores for each, are shown in Table 1 (correlate letters on table with outcomes listed in paragraph above). It should be noted that the scoring in Table 1 is situationally dependent; conflicts between outcomes would vary in different amphibious operations.

	a	b	c	d	e	f	g	h
a	—	0.0000000000	0.0000000000	2.0000000000	0.0000000000	0.0000000000	0.0000000000	1.0000000000
b	xx	—	3.0000000000	1.0000000000	2.0000000000	2.0000000000	2.0000000000	0.0000000000
c	xx	xx	—	1.0000000000	2.0000000000	1.0000000000	1.0000000000	2.0000000000
d	xx	xx	xx	—	0.0000000000	0.0000000000	0.0000000000	3.0000000000
e	xx	xx	xx	xx	—	1.0000000000	1.0000000000	2.0000000000
f	xx	xx	xx	xx	xx	—	1.0000000000	2.0000000000
g	xx	xx	xx	xx	xx	xx	—	1.0000000000
h	xx	xx	xx	xx	xx	xx	xx	—
Totals	0.0000000000	0.0000000000	3.0000000000	4.0000000000	4.0000000000	4.0000000000	5.0000000000	11.000000000
								31.000000000

Table 1. Scoring of Conflicting Interdependence Among Outcomes, Where Each Entry On Table Represents The Conflict Between The Outcomes Represented in Column i and Row j

(e) Uncertain or Probabilistic Linkages: Depending on the situation and the accuracy and volume of intelligence available, this could vary from low to high.

ix. Coordination Requirements

(1) Definition

Generally, coordination requirements is the degree to which dependencies between activities must be managed (Malone and Crowston, 1994, p. 90). This can be subdivided into external (the group with others) and internal (among members of the group) coordination. Four different types of dependencies that must be coordinated, and an example of each, are as follows:

(a) Shared Resources. Who, among a group of actors, gets which available and common resources (Malone and Crowston, 1994, p. 92).

(b) Producer/Consumer Relationships. When one member of a group uses the output of another, or a member of a group or the group as a whole uses the output of another entity, or this other entity uses the group's or a member of the group's output (Malone and Crowston, 1994, p. 93).

(c) Simultaneity Constraints. When two or more activities must be scheduled or synchronized (Malone and Crowston, 1994, p. 95).

(d) Task/Subtask. Goal selection and/or task decomposition within a group and/or among groups (Malone and Crowston, 1994, p. 95).

(2) Levels

A task would be given a grade for each of the four different types of dependencies listed above, and on both the internal and external level. Subjective grades such as High, Medium, Low, and None are probably most appropriate. Thus, each task would have eight coordination requirements grades associated with it.

(3) Example

(a) Shared resources: Two light infantry units each face an enemy armored threat, and there is only one section of antitank helicopters that can be used against those threats, and it is attached to one of the infantry units. Coordination required would be graded as High (internal) and Low (external). If the antitank helicopter asset is owned by an external agent, however, coordination required would be graded as Low (internal) and High (external).

(b) Producer-consumer relationships: During the conduct of

an amphibious assault, mine clearing helicopters must be used to clear mines from the approach to the landing beach. The landing force, then, is the consumer of the mine clearing helicopters' output. If we consider the "group" to be the amphibious task force, then coordination required would be High (internal) and Low (external). If we consider the "group" to be the landing force, however, then coordination required would be Low (internal) and High (external).

(c) Simultaneity constraints: During the latter stages of the same amphibious assault, an infantry unit must conduct an attack synchronized with close air support and naval surface fire support. If the "group" was considered to be the amphibious task force, the coordination required would be High (internal) and Low (external). If the "group" was considered to be the landing force, the coordination required would be Low (internal) and High (external).

(d) Task/Subtask: A landing force commander is given a mission of taking a specific objective. He must then divide the task up into subtasks for his subordinate units to complete. The coordination required in this situation would be High (internal) and Low (external).

x. Magnitude

(1) Definition

The magnitude of a task is the number of activities or subtasks that must be performed in order to complete the task.

(2) Levels

The magnitude of a task could be determined quantitatively by the number of activities that must be performed in order to complete the task. However, this requires a standardized definition of "activity," such that one activity is as difficult to perform as another, and decomposition of the task to the point where all activities are identified. Another way to assess the magnitude of a task would be to use an anchored scale. For example, magnitude could be measured on a one to one hundred scale, with "one" representing the task of pressing the space bar on a typewriter, and "one hundred" representing the task of constructing the United States Interstate Highway System.

(3) Example

The task of conducting an amphibious assault has many different activities or subtasks that must be performed, such as clearing the beach, making a reconnaissance, suppressing artillery with close air support, et cetera. On the one to one hundred scale mentioned above, the score would be about 30 for a significant amphibious assault.

xi. Resources Required

(1) Definition

Resources required to complete a task is defined as the resources other than information that the actors must possess in order to successfully complete the task in question.

(2) Levels

Resources required could be measured quantitatively by the number of resources required to complete a task, or could be graded on a subjective "High, Medium, and Low" scale. As is the case with magnitude, one must take care to ensure that there is a standard definition of resource, so that five resources in one instance is the same as five resources in another.

(3) Example

A landing force is given the mission of attacking an objective, and that objective requires three infantry companies to effectively overwhelm it. If the "base unit" of resources is one infantry company equivalent, then resources required to complete this task is three.

xii. Information Required

(1) Definition

Information required to complete a task is the information that the actors must possess in order to successfully complete the task in question.

(2) Levels

Information required is measured using the same method as resources required.

(3) Example

A Silkworm anti-ship missile site threatens an aircraft carrier battle group. However, it was reported in a residential area, so additional information (confirmation and precise location via U-2 imagery) is required before the commander can destroy that threat. If the base unit of information is one intelligence report, then information required to complete this task is two reports, the initial report and the confirmation report.

xiii. Task Formalization

(1) Definition

Task formalization is the level of specification and structure exhibited by the task (Davis et al., 1991, p. 22). A task with high formalization is defined in a very structured way; there are certain well-defined activities that must

be performed in a definite sequence in order to complete the task. In a task with low formalization, though, the activities required to complete the task, and possibly even the goals of the task, are poorly defined and open to interpretation.

(2) Levels

This dimension is again quite subjective, and the levels should probably be High, Medium, Low, and None, or some other discrete scale.

(3) Example

The task of calling for artillery fire against a visible target is very well structured. There are precise procedures that the forward observer must follow, using specific radio nets and message formats, that are ingrained from his earliest training. Task formalization for an artillery call for fire is High. However, the task of infiltrating enemy lines and destroying a prepared defensive position is not well structured — there are many ways that the task could be carried out, and the methods used and paths taken are not well formalized, but situationally dependent. Task formalization for the infiltration task is Low.

xiv. Dynamicity

(1) Definition

The dynamicity of a task is the degree to which one or more of the dimensions of the task changes over time. Dynamicity could refer to any of the dimensions described above, alone or in combination with others.

(2) Levels

This is quite subjective, and would probably best be graded as High, Medium, Low or None in each dimension, or possibly the number of changes per unit time in each dimension, if that is measurable.

(3) Example

Returning to our amphibious assault example, consider the task of conducting the assault across the beach. If the assault was conducted while the amphibious task force was still over the horizon, and retained the element of surprise, the task would be much different than if it was conducted later, when the amphibious task force was in view of the objective beach, and the element of surprise was lost. The later it was conducted, the better prepared the enemy would be for the assault. In each dimension, dynamicity is graded as follows:

Uncertainty: High (The later the assault is conducted, the less uncertainty)
Time Pressure: High (The later the assault is conducted, the more time pressure)
Complexity: High (The later the assault is conducted, the more complexity)

Coordination Requirements: High (The later the assault is conducted, the more coordination required)
Magnitude: High (The later the assault is conducted, the greater the magnitude)
Resources Required: High (The later the assault is conducted, the more resources required)
Information Required: High (The later the assault is conducted, the more information required)
Task Formalization: Low [Berigan, 1996)

D. EXCEPTIONS TO ORTHOGONALITY

The dimensions discussed are distinct, but related. If we can identify the interrelationships between the dimensions, we can compensate for the interaction by preventing variations from occurring in those dimensions the experimenter desires to hold constant. Not all the dimensions interact with each other, Berigan listed those dimensions that should have little or no interaction, and then discussed how changes in one dimension may affect some or all of the other dimensions.

> There should be little or no interaction between uncertainty and dynamicity, time pressure and dynamicity, complexity and dynamicity, coordination requirements and task formalization, coordination requirements and dynamicity, magnitude and task formalization, magnitude and dynamicity, resources required and task formalization, resources required and dynamicity, information required and task formalization, information required and dynamicity, or task formalization and dynamicity. All other interactions are detailed below.
>
> **xv. Uncertainty-Time Pressure**
>
> As uncertainty increases, the number of activities that an actor would have to perform in order to deal with the uncertainty well enough to complete the task could also increase (increased magnitude). If this number of activities increases while the time allowed to perform the task remains constant, time pressure will increase. Conversely, if time pressure increases, it could force the actor to complete the task before he is able to obtain all the information he wants, thus increasing uncertainty.
>
> **xvi. Uncertainty-Complexity**

As uncertainty increases, complexity can also increase. The number of attributes that must be taken into account in order to reduce uncertainty can increase, thus causing greater complexity. Additionally, if the uncertainty decreases the probability of the linkages between path activities and desired outcomes, this can cause an increase in complexity. Conversely, if the complexity increases, it should not necessarily affect the uncertainty.

xvii. Uncertainty-Coordination Requirements

Changes in uncertainty can cause changes in coordination requirements. If uncertainty increases, whether resources must be shared, which activities must be simultaneous, what must be produced and consumed, or which subtasks are required in the performance of a task can also become more uncertain, requiring greater coordination for any type of dependency in which the uncertainty is increased. Conversely, changes in coordination requirements should not cause changes in uncertainty.

xviii. Uncertainty-Magnitude

As mentioned under "time pressure," as uncertainty increases, the number of activities that an actor must perform in order to alleviate the uncertainty could increase, thus increasing the magnitude of the task. Conversely, an increase in magnitude could force the actor to complete the task before he is able to obtain all the information he wants, thus increasing uncertainty.

xix. Uncertainty-Resources Required

As uncertainty increases, resources required could increase, if those resources would be used to decrease the uncertainty or, in a case that involves two or more uses for certain resources, the uncertainty is enough so that the decisionmaker desires to use resources for all potential paths, in order to "cover all bets." An increase in resources required would not tend to drive an increase in uncertainty, however.

xx. Uncertainty-Information Required

As uncertainty increases, information required could also increase, because the decisionmaker would want more information in order to reduce his uncertainty. Changes in information required, though, should not cause changes in uncertainty.

xxi. Uncertainty-Task Formalization

Increases in uncertainty could also elicit increases in task formalization, since the uncertainty can involve the structure and paths taken to complete the task. This is not necessarily so, however; a task can still be highly formalized and well structured if some or many of the states, inputs, outcomes, or environments are not well known. Changes in task formalization should not drive changes in uncertainty.

xxii. Time Pressure-Complexity

Changes in time pressure can cause changes in complexity. If the time pressure decreases, the number of attributes or paths that can be considered can increase, because of the additional time the decisionmaker has to consider them. Also, uncertain or probabilistic linkages can decrease if time pressure decreases, because the decisionmaker has additional time to reduce his uncertainty. Conversely, changes in complexity can cause changes in time pressure. If complexity decreases, the amount of time that the decisionmaker must devote to sorting out the situation also decreases, and, if the amount of time available remains constant, time pressure will decrease.

xxiii. Time Pressure-Coordination Requirements

Changes in time pressure can affect coordination requirements. If the time pressure increases, coordination between two or more entities can become more difficult, or even impossible, because the time available to communicate and synthesize is lessened. Conversely, changes in coordination requirements can cause changes in time pressure. If coordination requirements are lessened, the amount of activities that must be performed is generally lessened, because some of those activities are coordination-related, such as the actors communicating with one another. Lessening the number of activities while holding the time available constant reduces time pressure.

xxiv. Time Pressure-Magnitude

Since time pressure and magnitude are directly related (time pressure is magnitude divided by time available), changes in one will cause changes in the other, unless the time available is modified accordingly.

xxv. Time Pressure-Resources Required

Changing time pressure would tend to have an inverse effect on resources required. If time pressure was increased, the resources required would tend to go down, because the actors would not have time to use all the resources that are available to them. Changes in resources required would tend to have a direct effect on time pressure — if resources required was increased, then time pressure would increase, because of the additional activities that would probably be required to put those resources to use, as long as time available is held constant.

xxvi. Time Pressure-Information Required

This interaction should be the same as the time pressure-resources required interaction.

xxvii. Time Pressure-Task Formalization

As time pressure is increased, task formalization would tend to increase, in those instances where there is a more structured way to perform a task that may

not achieve the goals of the decisionmaker as well as a less structured method will, but the more structured method would tend to take more time. As task formalization is increased, time pressure would tend to decrease, because more formalized tasks would tend to take less time because of the well-defined nature of the activities involved.

xxviii. Complexity-Coordination Requirements

Complexity and coordination requirements can affect each other in many subtle ways. For instance, if the number of possible paths is increased, coordination requirements could be increased, because of a possible requirement to coordinate with other team members in order to explore the paths. Or, increasing a shared resources requirement could increase the number of possible paths that could be taken. Changes to either of these dimensions must be scrutinized carefully to ensure any effect on the other has been accounted for.

xxix. Complexity-Magnitude

Increasing complexity can increase the magnitude of a task. If, for instance, additional activities must be performed in order to resolve a complex issue, then magnitude will increase. Additionally, if the magnitude of a task changes, and the added or decreased activities affect the number of attributes, paths, outcomes, interdependence, cues, or linkages present, then the complexity could increase or decrease as well.

xxx. Complexity-Resources Required

Increasing complexity of a task might require a different system or more personnel to aid in problem-solving than a more simple task would, thus increasing resources required. If resources required to complete a task were decreased, then complexity could decrease also, because the decrease in resources required could result in fewer attributes or paths that must be considered by the decisionmaker.

xxxi. Complexity-Information Required

Increasing the complexity of a task could increase information required, because the decisionmaker might want more information in order to help choose the right path, or decrease uncertainty of linkages between paths and outcomes. Increasing the information required could also increase task complexity, because the additional information required could be an additional attribute that the decisionmaker must consider.

xxxii. Complexity-Task Formalization

Increasing complexity can decrease task formalization. As the number of attributes, paths, and desired outcomes grows, the chore of formalizing a task can become more difficult, such that many extremely complex tasks are not formalized at all, because of the number of characteristics that must be

considered. Increasing task formalization may or may not increase complexity. Increasing formalization and adding a structured way of looking to the decisionmaking process could have the effect of decreasing complexity, or at least making the complexity more easily manageable.

xxxiii. Coordination Requirements-Magnitude

Increasing coordination requirements could increase the magnitude of a task, because greater coordination requirements could result in additional activities that must be performed in order to coordinate actions. Changes in task magnitude, however, should have little or no effect on coordination requirements, unless the activities that were added or deleted specifically involve use of shared resources, a producer/consumer relationship, a simultaneity constraint, or the task must be decomposed into subtasks by the decision makers.

xxxiv. Coordination Requirements-Resources Required

Changes to the coordination requirements should not affect resources required to perform a task. Increases in resources required, though, could cause coordination requirements to increase, because the additional resources required could cause a necessity to share available resources where one did not exist before, unless the resources available were also increased.

xxxv. Coordination Requirements-Information Required

Changes to coordination requirements should not affect information required. Increases in information required could lead to increases in coordination requirements, because the decision makers might need to coordinate actions in order to obtain the additional information.

xxxvi. Magnitude-Resources Required

Changes in the magnitude of a task should not affect resources required to complete a task, unless the added activities require more resources to perform them. Changes in resources required, however, could change the magnitude of a task, if the additional resources needed additional activities to be performed in order to put the new resources to use.

xxxvii. Magnitude-Information Required

Changes in the magnitude of a task should not affect information required to complete a task, unless the added activities require more information in order to perform them. Changes in the information required, however, could change the magnitude of a task, if the actors had to perform additional activities in order to obtain the added information.

xxxviii. Resources Required-Information Required

Changes in resources required to complete a task could cause changes in

information required, if the additional resources needed additional information in order to put the resources to use. Conversely, changes in information required to complete a task could result in changes in resources required, if the new information requirement needed additional resources in order to obtain the information. [Berigan, 1996)

E. SUMMARY

This chapter enumerated the dimensions of task structure, defined them, and demonstrated a method of grading the dimensions. These dimensions will be used to vary the overall complexity of the tasks/missions in the experiment as we develop the "***triggers***" or "***vignettes***" which will be used to stimulate adaption in the test organizations. Michael Berigan's review of the pertinent literature surveyed the possible sources of information and various opinions on dimensions of task structure. A set of task dimensions appropriate for the purposes of the A2C2 project was developed and defined and a comprehensive breakdown of these dimensions was provided. Exceptions to orthogonality of the dimensions were identified to aid in compensating for any effect which changes to one dimension might have on other related dimensions.

III. TASK STRUCTURE DIAGRAM AND TASK DESIGN PROCESS

This chapter focuses on the development of a task structure diagram concept. Definitions necessary to discuss decomposition of tasks into component subtasks and actions are given and the task structure diagram is described. The specific features and capabilities of the diagram are discussed followed by a description of how the dimensions of task structure developed in the previous chapter relate to the diagram. Finally, the concepts of Chapter II and this chapter are synthesized into a task design process that can be used to develop military operational scenarios, or more general tasks, in an experimental context.

A. INTRODUCTION

Determining the dimensions of task structure is an important area of experimental design for the A2C2 project. It establishes the groundwork for designing and differentiating tasks based on dimensions. Once dimensions are defined, a method is developed to assist the experimenter in visually describing the task structure, flow, and as many of the dimensions defined in Chapter II as necessary for expository purposes. A visual method makes the task design and differentiation less complex.

B. DEFINITIONS

The development of a task structure diagram involves decomposing tasks to the lower level activities from which they are constructed. In order to discuss the subject, we

must have common definitions for the various activities and define what is meant by task structure and task structure diagram. For the purposes of continuity in the A2C2 Project, I will use the same definitions for these terms as Michael Berigan's work for experiment 1.

1. Activity

An activity is any act that must be performed, at a high or low level of task decomposition. For our purposes, it is a generic term encompassing tasks, subtasks, and actions.

2. Task

A task is the macro level activity. It describes the overall activity that is being performed by the actors. Since it is really impossible to define beforehand the magnitude of the task, for our purposes, it is defined as the level that is the primary focus of the study.

3. Subtask

A subtask is a next-lower level component of a task. The nodes on a task structure diagram are subtasks. There can be more than one level of subtasks; if there are multiple layers, the highest layer of subtasks is subtask level 1.

4. Action

Actions are activities that are in their most elemental state for the uses of the study. Actions are either not further decomposable, or further decomposition would be impractical or would serve no purpose.

5. Task Structure

Task structure is defined as the flow of subtasks within a task in the time domain.

6. Task Structure Diagram

A task structure diagram is a visual model of a task which describes the task structure, and as many characteristics of a task as practical. The task structure diagram is designed to simplify understanding of the task and manipulation of potential variables. (Berigan, 1996)

C. TASK STRUCTURE DIAGRAM

Task structure diagrams based on Hatley and Pirbhai's data flow diagram (DFD) concept (Hatley and Pirbhai, 1988) will be used to provide a visual representation to experiment designers of the flow of subtasks and actions within a task. Dimensions of task structure are represented directly or inferred from this task structure diagram. By visualizing the structure of a task, experimenters are able to determine if a task accomplishes the objectives that have been set. Task structure diagrams provide a straightforward, pictorial method for comparing tasks and for describing a task outside the scenario design process. Experiment designers can also delineate task structures they are interested in testing, and the scenario developed to fit that structure. This "object oriented" view of task structure design allows designers to treat activities and nodes as modules, rearranging as necessary to achieve experiment scenario goals and objectives.

Highly structured or formalized tasks are easily described using this method, but some tasks are composed of numerous alternative subtasks. The alternative path options grow exponentially, until the labor involved in developing the diagram outweighs the benefits gained from its use. Figure 1 is an example of a task structure diagram. A description of the diagram and its building blocks is provided. 2.

1. Flow Description

Each diagram represents one task or subtask. The individual subtasks and actions within each task or subtask are the nodes, represented by the circles or rectangles. The task flows in time from the "start" box to the completion of the final subtask. Thus there may be many "levels" of diagrams for each task.

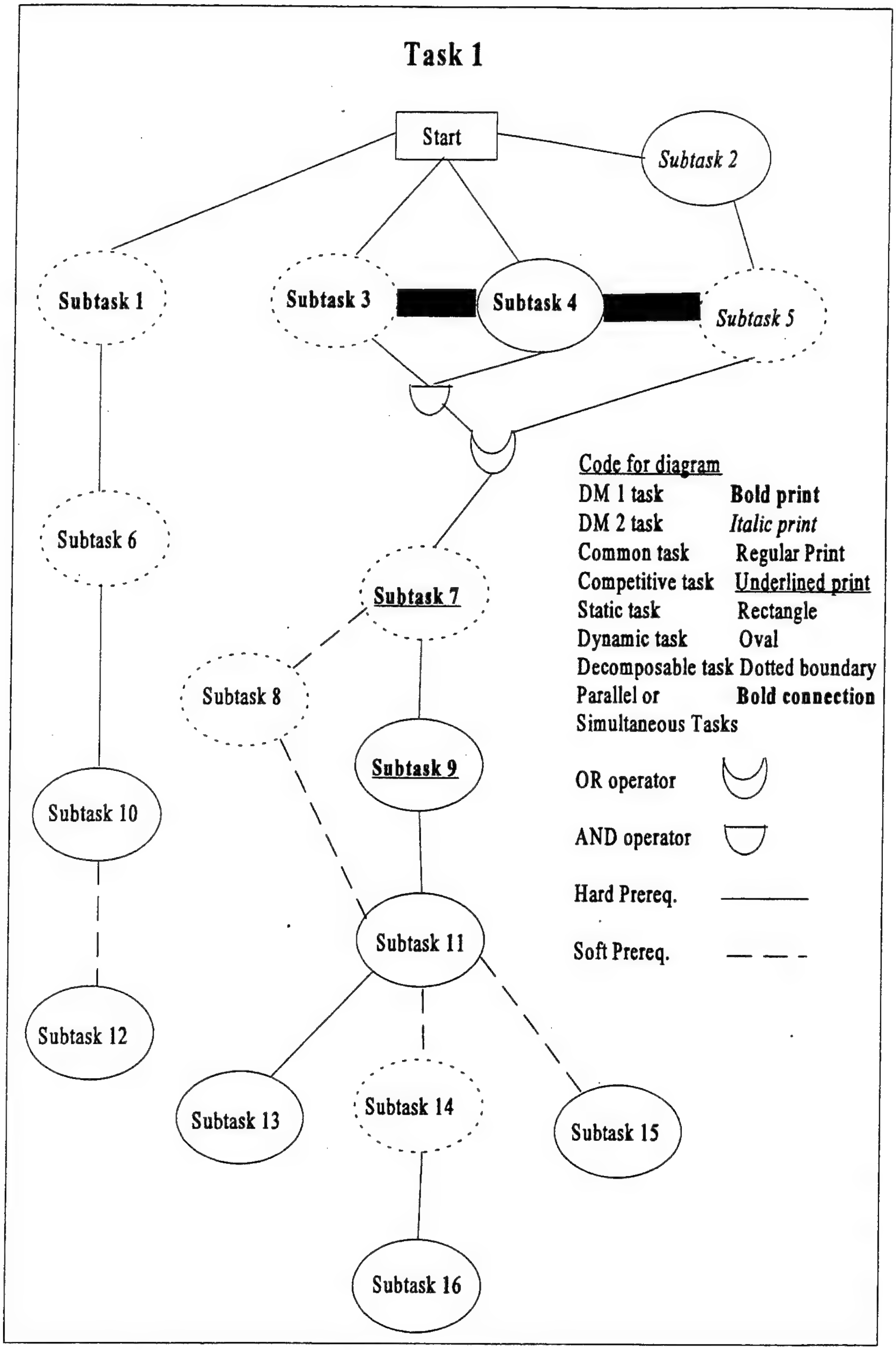

Figure 1: Task/Subtask Level Task Structure Diagram (from Berigan, 1996)

2. Actors

Actor refers to the Decision Maker who performs each subtask in Figure 1 and is represented by the style of type used for the name of the subtask. For example, if the subtask is given in bold type, then DM 1 is the task performer, if the subtask is given in italic type, then DM 2 is the task performer. If the subtask is in normal type, then both Decision Makers are involved in the subtask. If there are more than two actors are involved in a task, then a identification schema would have to be used. In Figure 1, decisions for subtasks 2 and 5 are made by DM 2, decisions for subtasks 3,4,7, and 9 are made by DM 1. All the other subtasks are common tasks and may be performed by several DM's. (This section of text from Berigan 1996 was modified to correct for figure number and changes to the figure.)

3. Decomposability

Decomposability implies that a task or subtask can be divided further into lower level subtasks or actions (Simon, 1981, pp. 196-210). Decomposability will be represented by the border of the figure representing each activity. A solid border represents an item that is not decomposable — the task, subtask, or action represented is at its most basic level. A dotted border represents an activity that can be broken down into lower level activities.

4. Simultaneity (same as Parallel)

Simultaneity is the requirement that two or more activities are to be performed concurrently or must be synchronized. Simultaneity is a dependency between actions that is included in the coordination requirements. Simultaneity is represented by a bold line joining the activities which have this dependency relationship.

5. AND Operator

The **AND** operator implies that all the activities feeding into it must be completed before the activities following it can be performed. The AND operator is represented in the diagram by a half-moon shape.

6. OR Operator

The **OR** operator indicates the requirement that one of the activities feeding into it must be completed before the activities following it can be performed. The OR operator is represented in the diagram by a crescent shape.

7. Competition

Activities are competitive if two or more actors require the same resource simultaneously to accomplish them. Competition is represented by underlining the title of the Competition is another of the coordination requirements dependencies, shared resources.

8. Dynamicity

Dynamicity is a measure of the change to one or more of the dimensions of a task over time. The shape of the figure representing the activity indicates Dynamicity; rectangles are non-dynamic, or static subtasks, and ovals are dynamic subtasks.

9. Prerequisites — Hard and Soft

Prerequisites are the activities that are performed prior to another activity. A prerequisite is considered a hard prerequisite if it must be performed prior to performing a given activity. A hard prerequisite is represented in the diagram by a solid arrow (line) connecting activities. A soft prerequisite is an activity which should be performed prior to a given activity for optimal results, but the following activity can be accomplished without the prerequisite being performed first. A soft prerequisite is denoted by a dashed arrow (line) connecting activities.

10. Decomposing Tasks into Subtasks and Actions

Figure 1 represents a task broken into subtasks. Some of the subtasks are in their elemental state — they are at the lowest activity or action level. Others can be decomposed at least one more level, some can be decomposed several more levels. Figure 2 represents a subtask decomposed into its elemental component actions.

11. Elemental State Task Structure Diagrams

The elemental state task structure diagram follows the same format as previously discussed for the task structure diagram. The elemental state task structure diagram contains a breakdown of the dimensions (see Chapter II) of task structure that apply to each action not previously shown in the task structure diagram (only those that are graded as other than "Low" or "None"), and the resources and information required to complete the action. (Berigan, 1996)

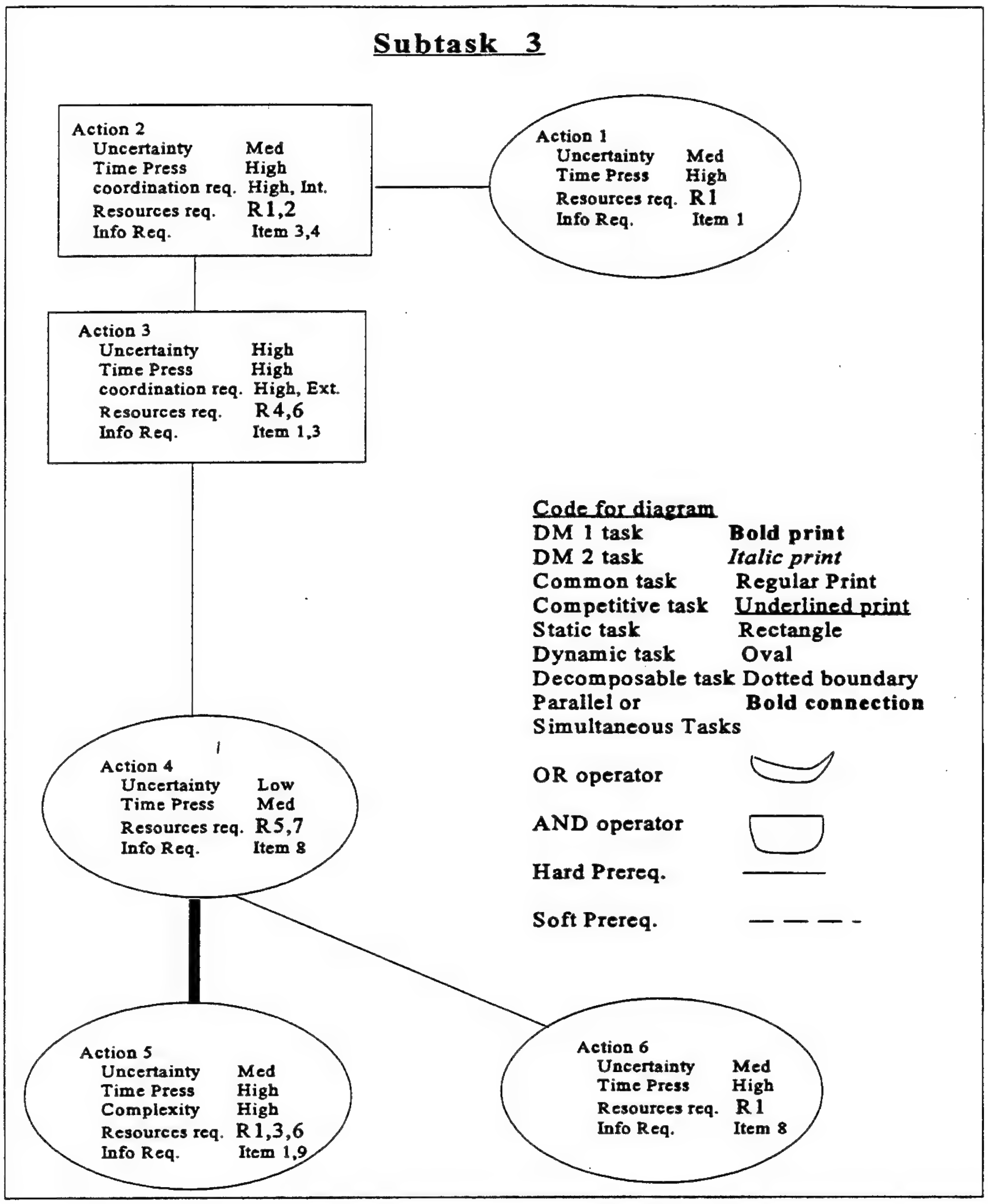

Figure 2: Subtask Decomposed To Its Most Basic Components
(Berigan 1996, p 41)

D. OPERATIONALIZING DIMENSIONS OF TASK STRUCTURE IN A TASK STRUCTURE DIAGRAM

For the task structure diagram and the dimensions of task structure to be of any use to us, we must be able to link the two issues. Each dimension of task structure must be delineated in the task structure diagram. Delineation of some of the dimensions in a task or subtask is straightforward, while others are more subtle. The manifestation of each of the nine dimensions of task structure in the task structure diagram is detailed in this section.

1. Uncertainty, Time Pressure, Complexity

Uncertainty, time pressure, and complexity are shown in the task structure diagram by assigning them a value in the diagram that shows a task in its most elemental state, (See Figure 2). The score for a subtask in each of these dimensions is the mean of the grades (scores) of all the actions that comprise the subtask; the score for a task in each dimension is the mean of the grades (scores) of all the subtasks that comprise the task. (Figure number modified to correspond to proper figure)

2. Coordination Requirements

Coordination requirements are shown several ways in the task structure diagram. If the grade for each dependency is High or Medium, it will be listed with the action in which it is associated on the elemental state task structure diagram. The different types of dependencies are represented in the diagram in the following ways:

a. Shared Resources

Competitive subtasks that are underlined implies competition over shared resources at a scoring level of Medium or High.

b. Producer/Consumer Relationships

Hard prerequisite indicators (a solid arrow connecting activities) in a task structure diagram imply that a producer/consumer dependency exists, the follow-on activity cannot be performed until the first is complete. Producer/consumer dependency is graded as Medium or High. A high score indicates a task or subtask that cannot be accomplished out of sequence, a medium score indicates the task or subtask can be completed out of sequence but

performance score will be significantly degraded.

c. Simultaneity Constraints

Simultaneity indicators (a solid bar connecting the activities) in the task structure diagram imply that simultaneity constraints are Medium or High. High indicates tasks or subtasks that must occur at the same time, medium indicates tasks that should be performed at the same time for maximum performance score.

d. Task/Subtask

The task structure diagram shows the breakdown of a task into its component subtasks and actions, and also depicts which actor or DM is assigned to complete each task or subtask. This is not the same as the allocation of tasks or subtasks by the DM's in the actual runs. This is the task/subtask dependency which not manifested in the diagram itself, except as the grade given in the elemental state task structure diagram .(Inserted for clarification of Berigan's work. In order for UCONN modelers to input the data into the model, they needed to have tasks and subtasks assigned to DMs or nodes, this was provided by the task structure diagram. This was not necessarily the actual division of labor that resulted in the experimental runs.)

3. Magnitude

The magnitude of a task is determined by counting the total number of actions in the task structure diagrams, starting at the highest level and breaking the task down to its elemental states.

4. Resources and Information Required

Resources and required information are listed in the elemental state task structure diagram. Counting the total resources and pieces of information required for each action within a task gives the total resources and information required for the task.

5. Task Formalization

Indicators of task formalization in the diagram are the ratio of soft to hard prerequisites (more soft prerequisites would imply less formalization), and the number of "or" operators (fewer "OR" operators implies more formalization). A task that can be readily displayed using the task decomposition method would have at least a medium level of formalization. Attempts to decompose tasks with low formalization would numerous alternative paths that decisions makers could take with no degradation in performance scores. (Berigan, 1996)

E. DESIGNING THE TASK

The scenario development and task design problem identified in Chapter I can now be approached in a straightforward manner. The process consists of four steps:

1. Determining the dimension of task structure of interest.
2. Determining the desired task structure.
3. Developing the scenario.
4. Grading scenarios by dimensions.

The second and third steps are interchangeable. This process will often be iterative, with at least the second, third, and fourth steps repeated more than one time.

1. Dimension of Interest

The goals of the experiment determine the dimension(s) of task structure (if any) that are of interest. If a task structure dimension is of interest, then task structure will usually be an independent variable. A researcher must determine what his dimension(s) of interest will be. He should then determine the number of levels needed based on the constraints of his experiment, and at least an approximation of the values the levels will take on. The researcher should also determine any of the other task structure dimensions he desires to hold constant, if important to his investigation.

2. Desired Task Structure

Several options are available for sequencing the development of the task structure diagram. If a specific structure or characteristic (such as simultaneity) is desired then a preliminary task structure diagram should be developed after the dimension of interest has been determined, filling in detail as the scenario is written. If no specific task structure requirement for the experiment exists, then the task structure diagram should be

developed concurrently with the scenario, using it as a briefing, explanation, editing, and grading tool.

3. Scenario Development

The scenario development should take dimension(s) of interest and desired task structure into consideration as well as ensuring the experiment fits within the other constraints and limitations, such as project context, other independent variables, subject pool, time and resources available, et cetera.

4. Grading Dimensions of Task Structure in Scenarios

In order to determine whether dimensions differ or are held constant, the scenario(s) should be graded based on the levels of dimensions of task structure as described in Chapter II.

F. SUMMARY

In this chapter a visual representation of a task's structure was developed using the data flow diagram (DFD) concept of Hatley and Pirbhai. Definitions necessary to discuss task decomposition were provided and the task structure diagram and its features described. The task structure diagram provides the dimensions of task structure, shows the flow of subtasks and actions in the time domain, and depicts optional paths, hard and soft prerequisites, and decomposability. A methodology was developed for designing a military operation scenario based on task structure.

IV. SCENARIO AND ORGANIZATION ARCHITECTURE FOR THE SECOND A2C2 EXPERIMENT

This chapter focuses on the development and modification of the scenario and organizational structures from the first NPS experiment for use in the second A2C2 NPS experiment. The second experiment evaluates two different organizational structures, one model-based, developed at UCONN, and the other developed at NPS using current military doctrine as the basis for its design. The tools developed in the preceding chapters are used to design the scenario tasks, develop an organizational structure, and provide inputs to UCONN modelers for generating their model-based, optimized organizational structure. A description of the resulting NPS and model-based organizational structures and an overview of the conduct of the experiment are also presented.

A. INTRODUCTION

The background information provided in Chapters II and III showed how a paradigm was developed for visually representing task structure, determining levels of dimensions of task structure, and stipulating a process for designing a task based on the task structure dimension of interest and desired task structure. The main focus of this thesis, the second NPS experiment of the A2C2 program, used this paradigm to design the experimental tasks and supporting scenario. An organization plans and prepares to accomplish a mission or task by the assigning its resources to appropriate DMs (commanders) in an organizational structure designed to accomplish that mission.

Investigating organization adaption is the primary goal of the A2C2 project. A basic premise of the A2C2 program is that an organization's structure should be "designed" based on resources available and tasks required to complete the assigned mission and that "significant" changes to the mission/task structure or a change in the organization's assets should induce changes in the organization's structure. The A2C2 research team elected to use an analytic-empirical approach to conduct model-driven experiments with human organizations in the context of a joint military scenario to examine these and other hypotheses in a controlled laboratory environment.

The NPS experiments thus far have utilized the Distributed Dynamic Decisionmaking (DDD-III) software (Kleinman, Young and Higgins, 1996), which was developed at UCONN and installed at NPS and other sites to support studies in organizational theory. The design of the second experiment is an extension of experiment one conducted at NPS in early 1996 (Kemple, Kleinman and Berigan, 1996).

The context for experiment two involved a Joint Task Force (JTF) in a six-node organizational hierarchy conducting a multi-faceted amphibious scenario that included maritime, ground, and air activities. The challenges of determining the dimensions of task structure to be varied, the task and organizational structures, and the development of a scenario for the second experiment will be discussed in this chapter.

Several issues needed to be resolved while designing the experiment:

- How to measure an organization's performance as they perform the same tasks, but with resources assigned to different organizational nodes that are also structurally different. A variety of task structures were required to see

if interactions between task and organizational structures exists.

- How can internal and external stimuli (called triggers) that are essentially equivalent in terms of the task load to resource ratio, be injected into the scenario to induce adaptation in the organizations. An internal stimulus is a change to resources or capabilities of the organization. An external stimulus is a change in the environment or mission.

Following is a description of the development of the scenario, organization structures, and the design and conduct of the second experiment.

B. DETERMINATION OF THE DIMENSIONS OF INTEREST

Coordination requirements between DMs to share limited resources to complete complex tasks is the task structure dimension of interest for the second experiment. A complex task is one that requires more than one resource type to be successfully completed.

The coordinated resources dependency varied over level one, internal coordination of resources -- the DM responsible for completing a task owns all the assets necessary to accomplish it; and level two, external coordination of resources -- the DM responsible for completing a task must work with one or more DMs to obtain the assets necessary to accomplish the task. Although it was desired to define dimensions of task structure that were independent from the organizational structures, whether the coordination for a particular task is internal or external is a function of the design of the organizational structure. (See Chapter II) The coordinated resources dependency level was a between

teams factor, with the TA teams experiencing a higher level than the NTA teams. This is because the NTA structure was specifically designed to minimize this dimension among other things. It was desired that all other dimensions of task structure be the same for both architectures until the triggers were introduced (discussed below).

The efficiency and performance of the organizational structures was of interest in the second NPS experiment. The organizational structures were: model-based, operationally-based, and dynamically selected by the subjects during the planning sessions. (The dynamically selected architectures will be discussed in Chapter V. The players did not function in the dynamically selected architectures as part of the second NPS experiment, but they are being evaluated with simulations by other research teams.) This interest results in the following research questions:

1. Does the performance of the model-based organization match the model's predictions of performance?

2. In the face of an internal "*trigger*", do teams adapt by changing organizational architectures?

3. In the face of an external "*trigger*", do teams adapt by changing organizational architectures?

4. Do organizations adapt their organizational structures based on changes in mission task and resources available?

5. Why and how do organizations adapt?

6. Are some organizational structures able to accommodate changes to mission or resources better than others (without a drop in performance)? Are some organizations

more robust than others? If so, why?

7. Can the model-based organizational structures developed by the modelers at UCONN, based on task structure and available resources, perform as well or better than organizational structures developed by the traditional method used by operational commanders as measured by performance, resources utilization, mission accomplishment, and losses?

These questions were the foundation for developing the hypotheses that were proposed for testing in the second NPS experiment.

C. RESEARCH ISSUES AND HYPOTHESES

From the goals and objectives of the A2C2 project and the general research questions described above, the A2C2 team formulated several general research issues which are the basis for the hypotheses of all the A2C2 experiments. These are:

1. Can model-based tools predict the optimum organizational structure to complete a mission given the task structure, available resources, and constraints?

2. Can the drivers for organizational adaptation be identified?

3. Can an adaptation to other organizational structures that perform better be predicted by model-based tools after task structure or resource changes ?

From these research issues, the major null and alternative hypotheses for the second NPS experiment were developed:

H_{01}: There is no interaction between task structure and organization structure, when *coordination requirement* is the dimension of interest.

H_{a1}: There is interaction between task structure and organization structure, when *coordination requirement* is the dimension of interest.

H_{o2}: Changes in levels of tasking will not cause organizations to adapt.

H_{a2}: Changes in levels of tasking will cause organizations to adapt.

H_{o3}: Changes in levels of resources will not cause organizations to adapt.

H_{a3}: Changes in levels of resources will cause organizations to adapt.

These hypotheses are based on the assertion that an organization will design its resources and organizational structure to accomplish its mission within acceptable limits of applicable constraints such as expected mission duration, total losses, casualties, and damage (own, enemy, and collateral), and other costs. The resources and tasks required to achieve a mission will influence the structure of the organization. Based on organizational theory (class notes from MN 3105, Organizational Structures, Fall Quarter 1996) the organization should adapt its structure when mission changes affect the task structure or there is a change in the availability of resources. This is most likely dependent on the degree of change in the mission, task structure, or resources. If the mission may be successfully completed by the existing organizational structure, there may be no adaptation. The motivation to change is based on the tradeoff between improved performance gained and the costs to reorganize. When the task or resource changes become large enough to affect the probability of successfully completing the mission, in the opinion of the commander, I believe this will induce change in the organizational structure. This will be investigated in experiment three at NPS in November 1997.

D. DESIRED TASK STRUCTURE

The mission, characteristics, task structure, and types of resources used in the first NPS experiment that were compatible with the goals of the second NPS experiment were reused where possible. This allowed more effort to be devoted to the organizational structure issues. Many of the same parameters and dimensions designed into the first experimental scenario were of interest in the second experiment. A higher level of workload on the DMs was desired as was a more balanced workload among DMs, so additional background tasks were added to the scenario. A background task is a minor task that can be handled by one asset or platform without assistance from, or coordination with, other DMs. The purpose behind a background task is to increase the workload on DMs and cause distractions, resulting in increased stress, time pressure, and ambiguity on the DMs.

1. Formalization of Scenario Task Structure

To test our hypotheses, the experiment was designed to measure the performance of teams attempting to perform the same mission, given the same resources and task structure, but using different organizational structures. Therefore a high degree of formalization in the design of the experiment was used, resulting in a consistent overall task structure form and replicable events that occur during each trial. The two initial organizational structures, traditional, and nontraditional, were perturbed by the systematic introduction of two levels of two factors, resource inventory at normal and reduced levels and task load at normal and increased levels. Traditional (TA) is the name given to the

organizational structure developed by the NPS researchers, nontraditional (NTA) is the name given to the model-based organizational structure developed by the modelers at UCONN. Replication and counterbalancing were used to control for other factors that might confound the results.

Based on the hypotheses for this experiment and the selection of the coordination requirement dimension of task structures, "limited capability" resources were used in order to require coordination between platforms and possibly DMs to successfully complete the assigned mission. A military force/platform may have the capability to complete more than one task or perform the same task in more than one way. For example, a DDG, in a real engagement, might fire enough rounds from a 5" gun to ensure destruction of a target without using ground troops or air support. In the experiment, if an asset could launch/conduct more than one attack at a time to perform a given task, DMs would be able to avoid the coordination requirements by assigning multiple attacks on a target by a single platform. Since the coordination events were the focus of the experiment, platforms were only allowed to conduct one attack on a single target at a time. An additional constraint placed on the attacks requiring coordination was that cooperating DMs only had a ten second window within which to commit their assets to the simulated attack, otherwise DDD considered them as separate attacks.

DDD requires certain amounts and types of resource mixes to successfully engage a target. If inappropriate assets are used, enemy targets escape unscathed and DDD subtracts team performance points. If inadequate resources are used, enemy targets are destroyed but the team loses performance points. An inappropriate attack is one that has a

zero capability value summed across participating resources (platforms) in one or more of the vector attributes required by the task. An inadequate attack was one that had a capability value summed across participating resources greater than zero but less than the task attribute vector value. See Tables 2 and 3 for examples of resource and task attribute vectors, they are discussed in detail later in this chapter. As an example, the amphibious landing on blue beach, listed as B. Beach row in Table 3, requires ten units of ground assault, twelve units of fire support, and eight units of armor. An appropriate attack (from Table 2) could consist of one rifle company and one section of CAS, the totals for this combination of assets would be two units of air, three units of ASUW, ten units of ground assault, twelve units of fire support, ten units of armor, ten units of hold, and two units of mine land; this meets or exceeds the required values for the task, other combinations of resources to successfully complete the task are also possible. An inappropriate attack could be two DDGs and a Cobra section. The totals for this attack would be 23 units of air, 24 units of ASUW, two units of ASW, 24 units of fire support, 13 units of armor, and 1 unit of mine land. Since the task requires ten units of ground assault and the assets attacking have zero ground assault capability, the attack is inappropriate. An inadequate attack could consists of one rifle company and a DDG. The totals for this attack would be 11 units of air, ten units of ASUW, one unit of ASW, ten units of ground assault, 11 units of fire support, eight units of armor, and ten units of hold. Since the task requires twelve units of fire support, the attack lacks sufficient combat potential in that one category, even though there is adequate combat potential in all other categories.

Asset	AIR	ASUW	ASW	GND ASLT	FIRE SUPP	ARMOR	HOLD	MINE SEA	MINE LAND	MED
DDG	10	10	1	0	9	6	0	0	0	0
FFG	1	4	10	0	4	3	0	0	0	0
CG	10	10	1	0	9	2	0	0	0	0
CV	0	0	0	0	0	0	0	0	0	0
LSD	0	0	0	0	0	0	0	0	0	0
LHA	0	0	0	0	0	0	0	0	0	0
LPD	0	0	0	0	0	0	0	0	0	0
Eng Plt	0	0	0	2	0	0	2	0	10	0
RFLECO	1	0	0	10	2	2	10	0	1	0
Str Det	5	0	0	0	0	0	0	0	0	0
COBRA SEC	3	4	0	0	6	10	0	0	1	0
Cas Sec	1	3	0	0	10	8	0	0	1	0
Ftr Sec	6	1	0	0	1	1	0	0	0	0
Huey Med	0	0	0	0	0	0	0	0	0	10
MCM HUEY	0	0	0	0	0	0	0	10	0	0
RECON AIRCFT	0	0	0	0	0	0	0	0	0	0
AAAV	0	0	0	0	0	0	0	0	0	0
MV-22	0	0	0	0	0	0	0	0	0	0

Table 2: Platform Attribute Vector values

Task Name	AIR	ASUW	ASW	GND ASLT	FIRE SUPP	ARMOR	HOLD	MINE SEA	MINE LAND
Hill	0	0	0	10	12	8	0	0	0
R. Beach	0	0	0	0	12	8	0	0	0
B. Beach	0	0	0	10	12	8	0	0	0
Seaport	0	0	0	20	10	4	0	0	0
Airport	0	0	0	20	10	4	0	0	0
Artillery	0	0	0	0	0	6	0	0	0
FrgLanhr	0	0	0	0	0	6	0	0	0
Silkwm	0	0	0	0	0	6	0	0	0
L. Mine	0	0	0	0	0	0	0	0	3
S. Mine	0	0	0	0	0	0	0	10	0
StrikeAir	5	0	0	0	0	0	0	0	0
Tac Air	10	0	0	0	0	0	0	0	0
Helo	5	0	0	0	0	0	0	0	0
Neu.Air	1	0	0	0	0	0	0	0	0
Tank	0	0	0	0	0	0	0	0	0
Neu.Gnd	0	0	0	2	0	0	0	0	0
Pt Boat	0	3	0	0	0	0	0	0	0
Sub	0	0	1	0	0	0	0	0	0
Neu. Sea	0	1	0	0	0	0	0	0	0
ASCM	6	0	0	0	0	0	0	0	0
Hold	0	0	0	0	0	0	1	0	0
Silk Air	6	0	0	0	0	0	0	0	0

Table 3: Task attribute vector values, the attributes for medivac capability (0 for all tasks except Medivac) and identification as an enemy (1 for enemy, 0 otherwise) were deleted from the table.

2. Prerequisites

Despite the desire for experimental control, the experiment was designed to allow variance in task structure execution at the unit level in order to accommodate differences

in organization structures and teams during the experiment trials. Player teams were given latitude in the execution of tasks by providing them multiple decision points with multiple options to complete tasks. Some resources used in an attack might induce errors or result in nonoptimal resources used in an attack, particularly involving the coordination events, e.g., the players' decisions regarding resource utilization coupled with the ten second window for coordinated attacks, time pressure, and other constraints. As a result, prerequisites leading to coordination events tended to be "hard" (see definition of hard/soft prerequisites in Chapter II), and prerequisites within the coordination events themselves tended to be "soft".

E. SCENARIO DEVELOPMENT

The scenario for the second experiment was adapted from the scenario used for experiment one and the joint officer interviews (Berigan, 1996/Alphatech, Inc., 1995). The goal was to design three variants of the same scenario, two to be used as training sessions without triggers and the other as the actual experimental scenario, including two vignettes within the experimental scenario to serve as trigger events that injected changes in mission or resources. The triggers were designed to induce organizations to adapt their organizational structure. The training and experimental scenarios were similar in format, but the training scenarios presented a significantly lighter workload for the DMs. This was to allow the players time to learn the "knobology" of the DDD simulation, train as a team, ask questions concerning the scenarios, and practice all the techniques necessary to operate in the DDD environment. Examples of all functions to be encountered in the

trials were included in the training scenarios to reduce training effects. No trigger events were introduced in the training scenarios.

After the experimental scenario design was completed, a detailed decomposition of the mission and resources was completed resulting in a detailed task graph. This effort produced the inputs required by the modelers at UCONN for developing the model-based organizational structure. Inputs required by the modelers included such items as:

- A list of tasks with sequencing, including total number of occurrences in the scenario and the probability of occurrence during each phase of the mission. See Tables 4a and 4b and Figure 3 for details.
- Resources available.
- Resource capabilities.

The two organizations used in the experiment to complete the mission were designated TA (NPS's structure that was manually derived using current military methods) and NTA (UCONN's structure that was model-based). These structures and how they were designed will be described later in this chapter.

After the experiment scenario was developed and resource allocation completed for each of the organizational structures, the scenario was converted into OPERATIONAL ORDERS (OPORDs) and the vignettes containing the trigger events were converted to ORDER MODIFICATIONS (ORDMODs) for each predetermined

Task	Obstacle 1		Obstacle 2		Obstacle 3		Obstacle 4		Obstacle 5	
	Prob.	Qty	Prob.	Qty	Prob.	Qty	Prob.	Qty	Prob.	Qty
Artillery	L	3	H	3	H	3	H	10	H	10
Frog Lncher	L	2	H	2	H	2	H	5	H	5
Silkworm	L	1	H	1	H	1	H	3	H	3
Mine Land	0	0	M	1	M	1	M	2	M	2
Mine Sea	0	0	H	1	H	1	H	0	H	0
Strike Air	L	1	L	2	L	2	L	3	L	3
Tactical Air	L	1	L	1	L	1	L	2	L	2
Helicopter	L	1	L	1	L	1	L	2	L	2
Neutral Air	H	2	H	2	H	2	H	10	H	10
Tanks	0	0	M	1	M	1	M	2	M	2
Neutral Grd	M	1	M	1	M	1	M	3	M	3
Patrol Boat	L	1	H	1	H	1	H	3	H	3
Submarine	L	1	M	1	M	1	M	3	M	3
Neutral Sea	M	2	H	2	H	2	H	10	H	10
Medivac	0	0	M	1	M	1	M	2	M	2
Swamp	H	0	H	~	H	~	H	~	H	~
Hold	L	0	L	0	L	0	L	1	L	1
Silkworm Air	H	1	H	1	H	1	H	3	H	3

Table 4a. Task Occurrence Probability and Quantity Inputs

Table Codes: H - High probability of occurrence (1.0)
M - Medium probability of occurrence (.6)
L - Low probability of occurrence (.3)
0 - Zero probability of occurrence
~ - Does not occur on roads, full coverage of areas around roads

Task	Defend 1		Defend 2		Defend 3		Defend 4		Defend 5		Defend 6		Defend 7	
	Pro b	Qty	Pro b	Qty	Pro b	Qty	Pro b	Qty	Pro b	Qty	Pro b	Qty	Pro b	Qty
Artillery	0	0	0	0	H	15	H	15	H	15	H	3	H	3
Frog Lncher	0	0	0	0	H	10	H	10	H	10	H	2	H	2
Silkworm	H	10	H	10	0	0	0	0	0	0	0	0	0	0
Mine Land	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Sea	L	0	L	0	0	0	0	0	0	0	0	0	0	0
Strike Air	H	3	H	3	H	3	H	3	H	3	H	1	H	1
Tactical Air	H	3	H	3	M	1	M	1	M	1	M	1	M	1
Helicopter	H	3	H	3	H	2	H	2	H	2	H	2	H	2
Neutral Air	H	8	H	8	H	4	H	4	H	4	H	4	H	4
Tanks	0	0	0	0	H	2	H	2	H	2	H	1	H	1
Neutral Grd	0	0	0	0	H	3	H	3	H	3	H	2	H	2
Patrol Boat	H	4	H	4	0	0	0	0	0	0	0	0	0	0
Submarine	H	2	H	2	0	0	0	0	0	0	0	0	0	0
Neutral Sea	H	8	H	8	0	0	0	0	0	0	0	0	0	0
Medivac	0	0	0	0	M	0	M	0	M	0	M	0	M	0
Swamp	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hold	0	0	0	0	H	1	L	1	L	1	H	1	H	1
Silkworm Air	H	?	H	?	0	0	0	0	0	0	0	0	0	0

Table 4b. Task Occurrence Probability and Quantity Inputs

Table Codes: H - High probability of occurrence (1.0)
M - Medium probability of occurrence (.6)
L - Low probability of occurrence (.3)
0 - Zero probability of occurrence
? - Occurrence of this item dependent on team performance, task spawned only if team fails to properly perform parent task.

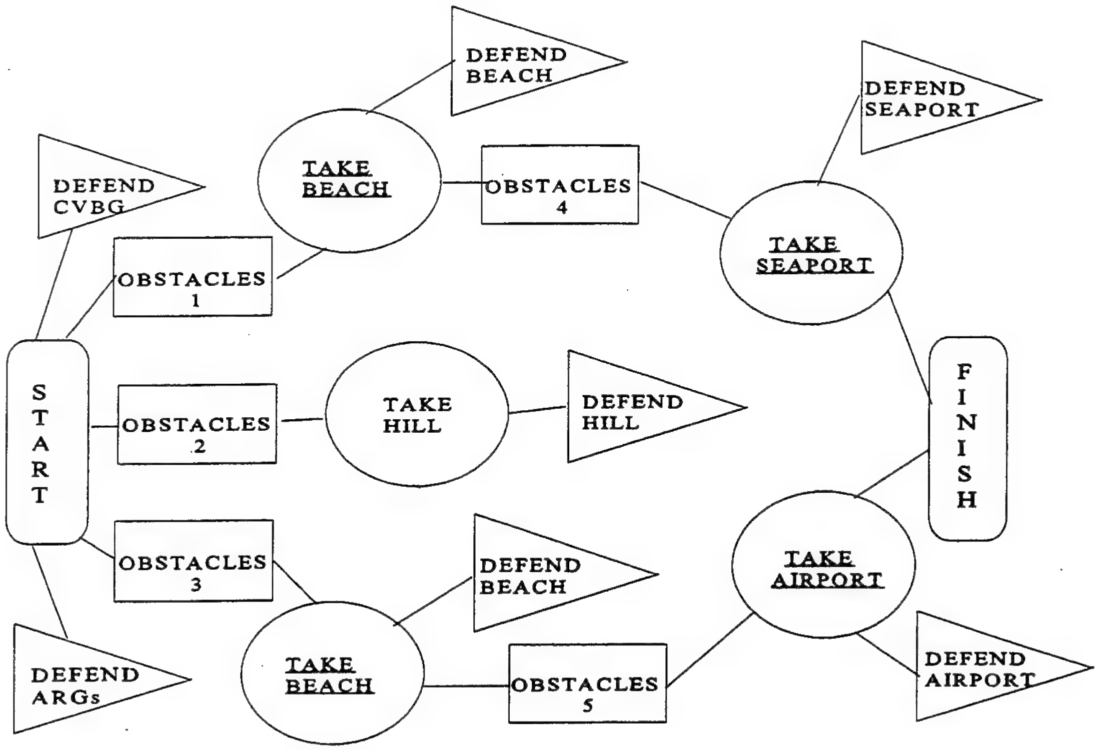

Figure 3. Overall Mission Task Graph

initial organizational structure. An OPORD is a narrative providing directions on how the overall operation is to be conducted and includes such items as asset availability and ownership, tasks to be accomplished, time lines, and intelligence reports. The military issues OPORDs to task and provide guidance to the Commander Joint Task Force (CJTF) and his subordinate commanders. A copy of the OPORDs and ORDMODs are included as Appendix A. Detailed descriptions of the information provided to the players in the OPORDs as well as experimental control issues such as scenarios, general situation, enemy situation, mission, friendly forces and asset ownership, how the mission will be executed by friendly forces, mission, mission priorities, the manner in which the scenario

should unfold, and the organizations tested follows.

1. Scenario Background

The scenario for experiment two is similar to the scenario for NPS experiment one and is abstracted from the OPORD contained in Appendix A.

The neighboring nation of Yang has attacked the nation of Ying, which is a U.S. ally. Attacking forces have succeeded in seizing the Yingian port of Plethora and the nearby international airport. The Yingian government has requested U.S. assistance in taking back the port of Plethora and driving Yangian forces from Ying (See Figure 4).

The port of Plethora is protected by obstructions, mines, obstacles, and the

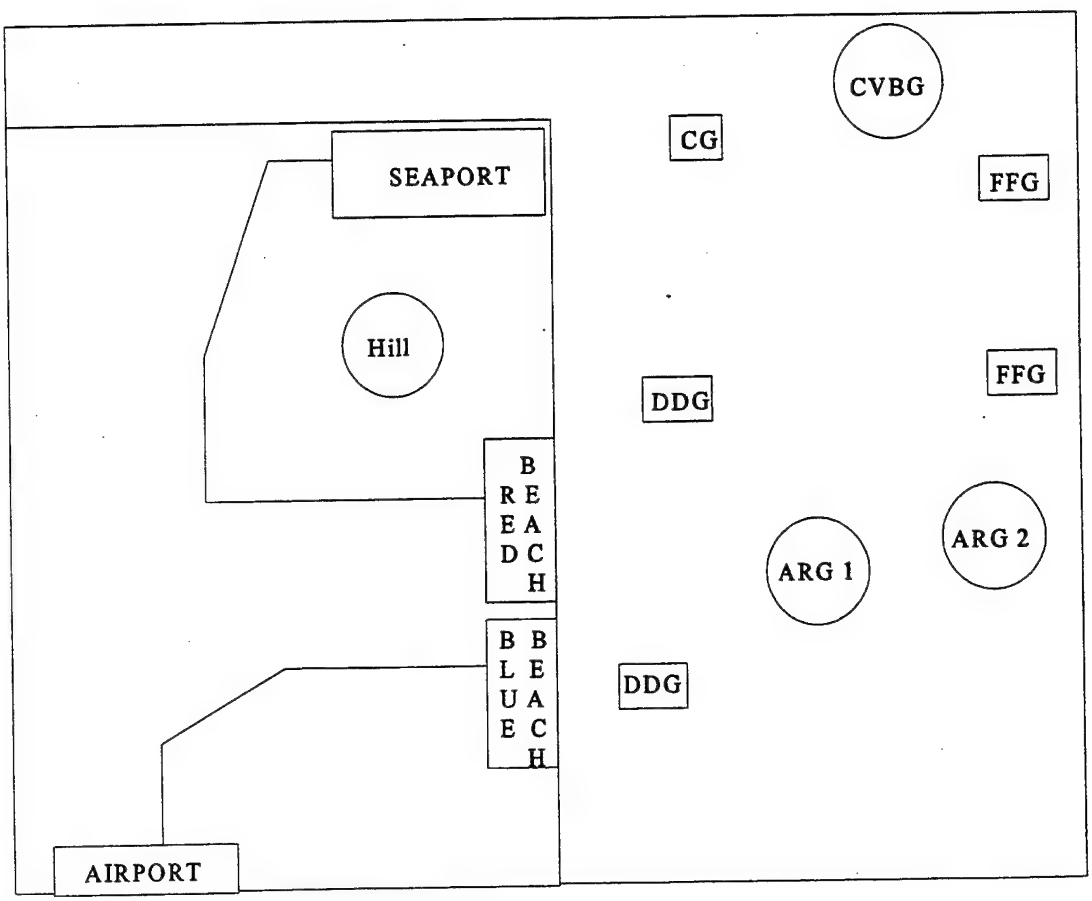

Figure 4: DDD Area Map

presence of hidden enemy among the port facility buildings. Two beaches approximately 5 miles south of the port are to be the sites of the amphibious assaults. The northernmost beach (designated "Red Beach") has a road leading to the port. The southernmost beach (designated "Blue Beach") has a road leading to the airfield. Waterborne approaches to the beaches are/may be mined. There is a hill to the north of Red Beach occupied by an enemy heavy mortar platoon with a platoon of infantry for security. This terrain dominates both Red Beach and the port. It must be taken and retained for a successful attack on Red Beach and the port. At the port, but hidden from view, is a company-sized armored counterattack force that can move toward Red Beach in response to any amphibious assault. Similar counterattack forces exist at the airfield, which is located about 5 miles inland from Blue Beach. These counterattack forces could inflict serious damage if not interdicted before they reach either beach. The off-road terrain between the beaches, port, airfield, and hill is swampy and treacherous; it is unsuitable for travel. Thus, all travel must be on the two roads. Both of the roads may be mined, but locations of the minefields, if any, are unknown. The port, airfield, both roads, both beaches, and hill are located within range of enemy artillery strong-points which must be suppressed. The northernmost strong-point can shoot at Red Beach and the port. The southernmost strong-point can shoot at both Blue Beach and the airfield. The artillery pieces are housed in reinforced concrete bunkers, with ammunition stored in bunkers deep underground. Even concentrated air attacks will not completely disable the artillery strong-points. The enemy can wheel out artillery pieces (from 8 to 24 at a time), set up, sight in, and fire within 5 minutes. If friendly forces can get effective ordnance on target

in less than 5 minutes, the enemy will wheel their artillery pieces back into the bunkers and wait until another time.

Enemy Frog (SCUD-like) Missile Launchers, capable of carrying chemical munitions, are hidden in the vicinity of both artillery strong-points. They can emerge from covered positions, prepare warheads, and fire missiles within 10 minutes. They must be destroyed by an appropriate combination of ordnance.

The submarine threat to the ARG and CVBG is considerable. Enemy Alfa-class submarines are known to be in the area. These submarines must be detected and destroyed to protect the fleet.

The enemy possesses HIND helicopters with the capability of launching anti-ship missiles. The CG, DDGs, FFGs, and aircraft possess capabilities to counter these helicopters.

The enemy has significant air strike capability and can launch anti-ship missiles from most of its strike aircraft.

The enemy's Special Forces possess numerous fast patrol boats that can fire very potent torpedoes or be loaded with explosives for suicide missions. These can be engaged and destroyed by the CG, DDGs, FFGs, fighters, and Cobras.

There are Silkworm threats throughout the area. The Silkworm missile launchers have been placed in residential neighborhoods because they know the U.S. will be reluctant to target residential areas. Accordingly, if U.S. warships want to target a Silkworm launcher, they must first get visual confirmation of its presence, using theater reconnaissance (RECON) (TARPS) assets, and any strike mission must use precision

guided munitions.

A Joint Task Force (JTF) has been organized by a notional theater commander in chief, the CINC, in order to capture the port and airfield to allow for the introduction of follow-on forces. The CINC's ultimate purpose will be to drive Yangian forces from Ying and destroy their capability for offensive warfare. The Commander, JTF (CJTF) has at his disposal an aircraft carrier, an AEGIS cruiser, two DDGs, two FFGs, two LPDs, two LHDs, 10 sections of FA-18s, 8 sections of AV-8Bs, four sections of Cobras, two mine countermeasure helos, two MEDIVAC helos, one TRAP reconnaissance aircraft, three AAAV companies, six rifle companies, two Stinger detachments, and two engineering platoons. Figure 4 (page 56) gives a representation of the operation area.

2. Friendly Situation and Assets

The following groups the assets in generic component task groups or units; the DM that will "own" and control each asset during DDD play is dependent on the organization structure. (See Figures 5 and 6 for details about organizational structures)

There are a theater-level Joint Force Air Component Commander (JFACC) and other friendly forces conducting independent operations against the enemy in Ying, not in concert with the JTF. The presence of these independent friendly units and neutral platforms forced the CJTF to identify contacts prior to attacking to ensure friendly and neutral forces were not destroyed. The identification process also provided information needed by the DMs to assign the right mix of assets to successfully attack a hostile unit when appropriate. The aircraft from the CVBG available to support the JTF are the 10 sections of FA-18s, 8 sections of AV-8Bs and 1 FA-18 TARPS aircraft. The FA-18s with

laser guided bombs can attack FROG launchers and confirmed Silkworm (land-based anti-ship missile) missile sites, or they can be used for anti-air warfare, and to man combat air patrol stations. The AV-8Bs can be used to provide close air support to the ground troops. The FA-18 TARPS can be used for reconnaissance only.

MEU 1 is composed of one Advanced Amphibious Assault Vehicle (AAAV) mounted infantry company, two MV-22 Osprey mounted heliborne infantry companies, one division of AH-1W Cobra attack helicopters, one division of mine countermeasures (MCM) helicopters (indivisible), one engineer platoon, and a division of MEDEVAC helicopters (indivisible). MEU 2 is composed of two AAAV mounted infantry companies, one V-22 mounted heliborne infantry company, one division of AH-1W Cobra attack helicopters, one division of mine countermeasures (MCM) helicopters (indivisible), one engineer platoon, and a division of MEDEVAC helicopters (indivisible). Each MEU will be considered to have an unmanned aerial vehicle (UAV) flying in its support for the duration of the operation. The players will not control the UAVs but their presence will be represented by the nearly omniscient battlefield picture each MEU will possess.

As mentioned previously, the assets were designed so that single assets could not successfully accomplish a coordination event task; coordination was required to assign multiple assets to achieve the right mix for a successful attack. Various combinations of assets are capable of accomplishing each coordination task. Single assets could make repeated attacks on a target, but in this experiment, DDD-III would assign a penalty and the attacking unit would not be assured of destroying the target. This was done to force

coordination where the experimental designers wanted it to occur.

The asset-to-task matching was implemented on DDD-III via specification of task resource requirements and asset resource capability. Each task and asset is associated with a 9-dimension resource vector R = (r1, r2, ... , r9) as shown in table 2, with components that correspond to task requirements or combat capability/potential in various categories (r_i's). For example, r0 = air combat, r1 = sea combat, ..., r6 = holding/occupying, r7 = sea mines, r8 = land mines, r9 = medivac. Assigning a set of values to R for a specific task (see Table 3) establishes what mix of assets, with their corresponding sum of R values, is sufficient to correctly process that task. Thus, mine-clearing helicopters have relatively high values assigned to r7 corresponding to the combat potential of that unit for sea mine tasks. Other assets with other primary capabilities would have lower values assigned to r7, or zero (Kemple, et al., 1996). A coordination event such as taking a beach would require sufficient values in the r_i elements for ground assault, armor, and hold that could not be satisfied by any one asset but could be satisfied by several different combinations of assets. The R values of all assets assigned to attack a task are totaled within each r_i to determine whether the assigned units have sufficient collective combat potential to complete the task. If the combined R values of the assigned assets are greater than or equal to each component of the R values of the task, the team is credited with a successful attacks without losing points. If the combined R of the assigned assets are less than R of the task in any component (inadequate attack), the target is destroyed but the team is penalized a predetermined number of points. If assets with collective r_i's = 0 in required combat

potential areas are assigned (an inappropriate attack), the target is not killed and the team again loses points.

A summary of the assets available and assigned owners is shown in Table 5. The combat potential for each asset is shown in Table 2. Penalty points are levied in a binary fashion; either the task is completed successfully and no points are deducted or it is not and the maximum penalty points are deducted.

3. Mission

In order to successfully complete a trial, a set of coordination and background tasks must be completed in priorities and sequence within 40 game minutes. The CJTF and his subordinate commanders (the team participating in the trials) must accomplish the following:

Ground Component: To secure the port and airfield of Plethora, allowing for the introduction of follow-on forces. In order to achieve these objectives, enemy forces and defenses must be identified, engaged and defeated.

Maritime Component: To support the amphibious operation with close air support (CAS), naval surface fire support (NSFS), mine countermeasures, and air defense and medivac assets, and to defend the CVBG and ARG from air, surface, and subsurface threats.

The specific DM-to-task assignment is dependent on the organizational structure and assignment of resources.

Platform	Owner in TA	Owner in NTA	Total Qty
DDG	DM 1/DM 3 (1 ea)	DM 4	2
FFG	DM 2	DM 5	2
CG	DM 2	DM 4	1
CV	DM 2	DM 0	1
LSD	DM 3	DM 4	1
LHA	DM 1	DM 5	1
LPD	DM 1/DM 3 (1 ea)	DM 4/DM 5(1 ea)	2
Eng Plt	DM 4/DM 5 (1 ea)	DM 4/DM 5(1 ea)	2
Rifle Company	DM 4/DM 5 (3 ea)	DM 1/DM 3 (3 ea)	6
Stinger Detachment	DM 1/DM 3 (1 ea)	DM 1/DM 3 (1 ea)	2
Cobra Section	DM 4/DM 5 (2 ea)	DM 2/DM 3 (2 ea)	4
CAS Section	DM 2	DM 0	8
Fighter Section	DM 2	DM 5	10
Huey Med	DM 1/DM 3 (1 ea)	DM 4/DM 5(1 ea)	2
MCM Huey	DM 1/DM 3 (1 ea)	DM 4/DM 5(1 ea)	2
RECON Aircraft	DM 0	DM 0	1
AAAV	DM 4(2)/DM 5 (1)	DM 1(2)/DM 3 (1)	3
MV-22	DM 4(1)/DM 5 (2)	DM 1(1)/DM 3 (2)	3

Table 5: Assets, owners, and quantities of each available

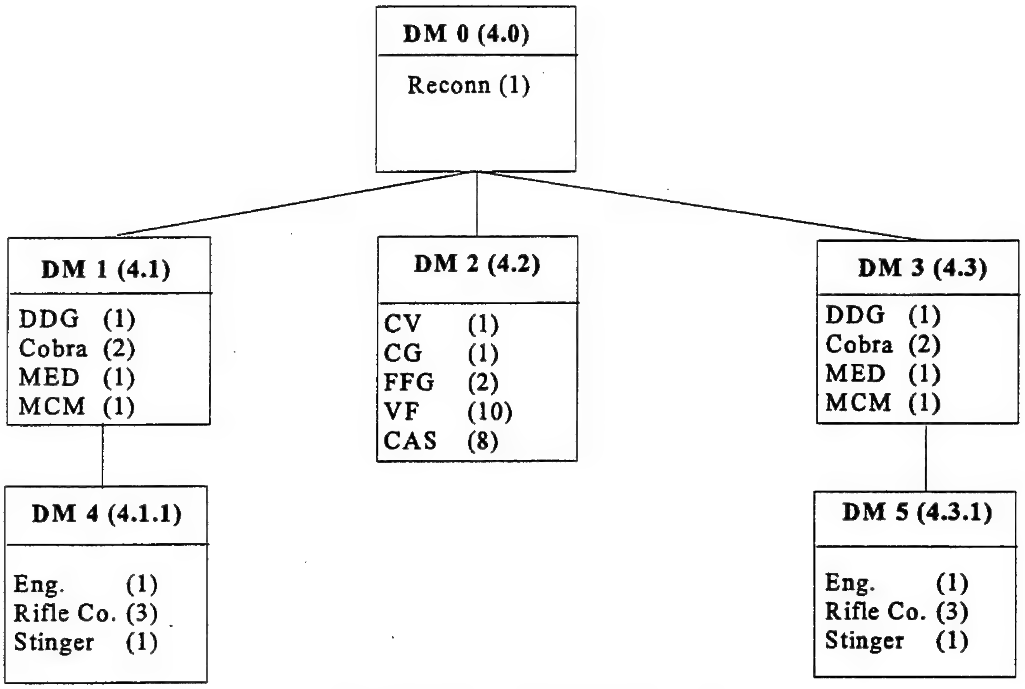

Figure 5: Traditional Architecture

4. Execution

Each MEU simultaneously lands an AAAV-mounted company on the beach. MEU 1 attacks Red Beach, and MEU 2 attacks Blue Beach. MEU 1 simultaneously secures the commanding terrain overlooking Red Beach and the port with its heliborne company. Once the beaches and commanding terrain are secure, the two AAAV-mounted companies proceed down the roads from their respective beaches, clearing minefields with the engineer platoons, killing counterattack forces with the Cobras, and conducting MEDEVACs as necessary.

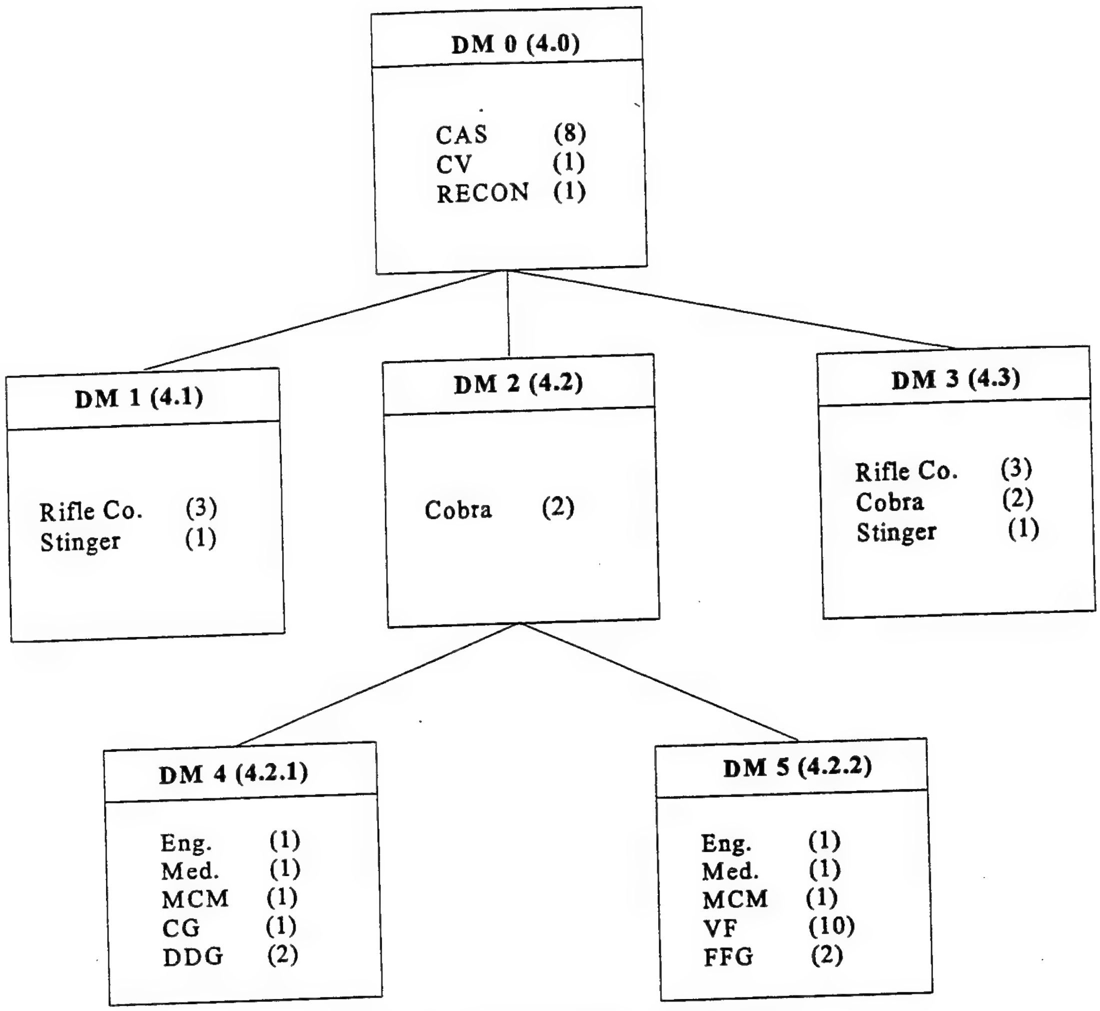

Figure 6: Nontraditional Architecture

Each MEU has an unmanned aerial vehicle (UAV) (launched from the ARG) airborne for the duration of the operation. The UAVs keep the artillery strong points and the suspected FROG sites under constant surveillance, so that NSFS or CAS assets can be brought to bear immediately if they are needed.

Once the roads have been cleared, the AAAV-mounted companies from MEU 1 and MEU 2 attack the port and the airfield, respectively. MEU 2's AAAV-mounted

company is joined in its attack by a heliborne company from MEU 2. It is important that, once the AAAV-mounted companies land on the beach, the airfield and port be taken as quickly as possible, before the enemy has a chance to organize his defense and send reinforcements. It is desired that final assaults on the airfield and port be conducted simultaneously, in order to present the enemy commander with the most confusing, dilemma-filled environment possible, but if one attack must be conducted before the other, the airfield takes priority. If the airfield attack is held up for any reason, the port attack should wait to retain the synergism of concurrent attacks; if the port attack is held up, the airfield attack should go forward.

Due to hydrographic limitations, the ARGs and the CVBG have to be significantly separated during the operation, enough to preclude them from being under a joint air defense umbrella provided by the AEGIS cruiser. Thus, the AEGIS cruiser should remain with the CVBG, but position itself so that it can rapidly move from the CVBG to the ARG if that becomes necessary. Additionally, the two destroyers are to be inshore, providing NSFS support, while the frigates are the primary anti-submarine warfare platform for the CVBG. The frigates performing anti-submarine warfare should, like the AEGIS cruiser, position themselves so that they can quickly move to support the ARG if that is necessary.

The ARG launches the Marines for the initial assault on Red and Blue Beaches. The ARG will launch the mine countermeasures helicopters, Cobras, MEDEVAC aircraft, the air assault for MEU 2's attack on the airfield, etc. when called to do so. The destroyers will provide NSFS to suppress the artillery strong points ashore when

requested to do so by either of the MEUs.

The CVBG is to keep two sections of FA-18s with precision guided munitions on standby at all times: one to be used against FROGs (in support of the MEUs) and the other against Silkworms (in support of the CVBG or ARG). The CJTF will be launch authority for both sections. The CVBG is to also provide two sections per hour of air defense aircraft (FA-18 or F-14), with one combat air patrol station over the CVBG the other over the ARG.

If a suspected Silkworm launcher is detected, it must be identified first by the FA-18 TARP before it can be destroyed. A Silkworm launcher detected at the northernmost site threatens the CVBG, at the southernmost site, the ARG.

5. Priorities

The JTF's overall priority, and the priority within the ground component, is MEU 2's attack on the airfield, because the initial buildup of friendly forces can be most quickly and effectively achieved through air transport.

The following CJTF's priorities were given to the players within the maritime component: if both the ARG and CVBG are threatened by the enemy, the ARG has priority of support against submarine threats, fixed-wing air threats, and patrol boats. If there is a threat of an air attack against the ARG, the ARG should get the AEGIS cruiser and a combat air patrol.

The frigates, performing anti-submarine warfare, and the AEGIS cruiser, performing anti- air warfare, stay with the CVBG unless a necessity occurs with the ARG, because the CVBG is considered a more likely target for the enemy. The CVBG

has priority against land-based Silkworm sites and helicopters.

F. DEVELOPMENT OF THE TRAINING SCENARIOS

In order to familiarize the subjects with the general situation in the scenario and the DDD III simulation (the operational context and activities required such as requesting assets, communicating using voice and preformatted message sets, et cetera), I created two training scenarios based on the experimental scenario. The training scenarios were identical to the experiment scenario, except they did not contain as many coordination events, as high a workload, or trigger events.

1. Development of Organizational Structures

The design of the experiment required two organizational structures to test the hypotheses. One, called the Traditional Architecture (TA) was designed based on military principles, the other organizational structure was provided by the modelers at UCONN and was based on minimizing coordination between DMs (external coordination). Transfer of assets between DMs was not allowed. This organizational structure was called the Nontraditional Architecture (NTA). The organizations are structurally different, yet logically and efficiently designed.

a. *Traditional Architecture Organizational Structure*

The TA organizational structure developed at NPS was based on the principles for force structure organizations delineated in Joint, Service, and Component Doctrine. The principles were:

1. Design the organization structure in a way that clearly defines the structure of

authority, responsibility, and ownership of assets, establishing a network of relationships among commanders delineating communications channels, chain of command, authority and responsibility, and unity of command.

2. Provide framework for building task forces and task groups.

3. Provide a reasonable span of control (varies with each situation)

> "... command and control organizations must be able to handle and disseminate information efficiently. We generally favor more decentralized organizations, which can process information more quickly, to maintain a high tempo of operations."(Marine Corps Doctrine Publication 6, 1996)

4. Provide Unity of Effort: Unity of effort implies ..."that all the participants in an operation strive to shape their efforts toward a common goal. It does not imply rigid, centralized control, but rather cooperation, coordination, and mission control."(Naval Doctrine Publication 6,1996)

5. Provide Simplicity of communications - Fully connected (open) communications between nodes does not constrain the design of task organizations or adaptation.

6. Provide Economy of force - Economy of forces means that the minimum quantity of personnel, equipment, and other necessary resources are committed to the mission to ensure overwhelming force can be applied. Economy of force minimizes the cost of the mission in terms of casualties and damage during the mission and in monetary terms.

7. Organize and control battle space and manage information.

Other factors that influenced the selection of the organizational structure were pattern matching, history, and past experiences. Pattern matching refers to the aspect of humans to look for similarities or patterns between a current problem or situation and previous experiences, and then tailor the solution for that problem to the present one. Figure 7 shows the organizational structure and ownership of assets for the traditional organization. (Figures 7 and 8 are replicates of Figures 5 and 6, placed here for the readers convenience)

In Figure 7, the TA organization, DM 0 would be equivalent to the CJTF with overall responsibility for the operation. DMs 1 and 3 would equate to ARG 1 and 2 respectively. DM 2 would be the carrier battle group commander, providing air support for the operation, the joint force air component commander (JFACC), and handling the duties of the maritime component commander (MCC). DMs 4 and 5 would be the MEU 1 and 2 commanders.

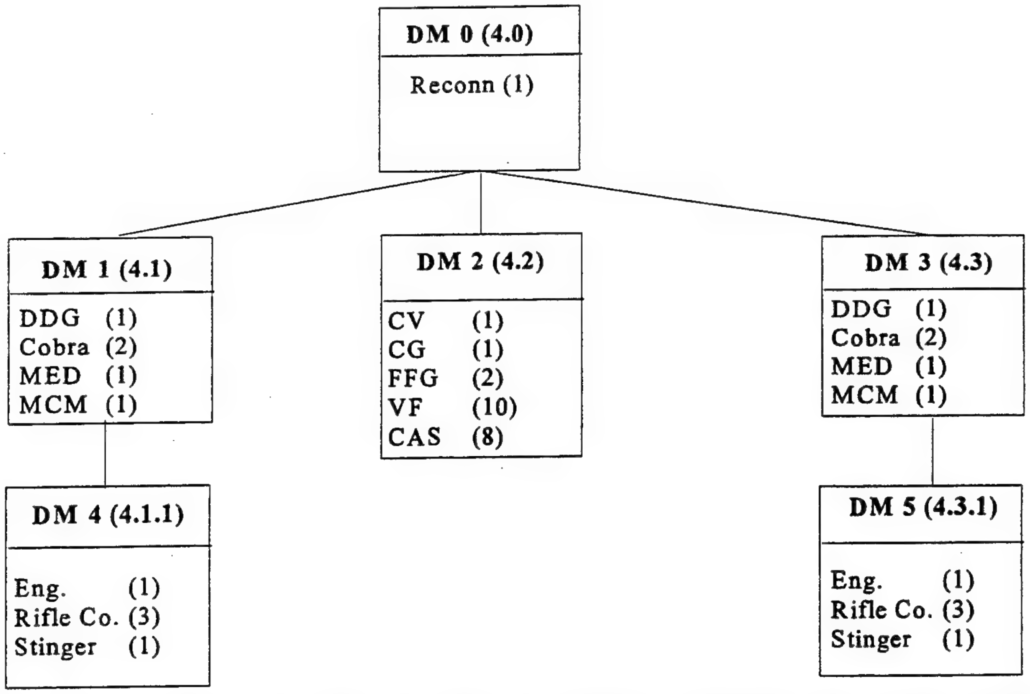

Figure 7: Traditional Architecture (same as Figure 5, provided here for convenience)

b. *Nontraditional Architecture Organization Structure*

In order for the UCONN modelers to design an organizational structure based on the mission, they needed detailed information about the mission, tasks, task structure, probabilities of encountering each task/subtask, assets, and asset capabilities. The models then used to design an organizational structure and assign asset ownership to the structure based on expected/probable tasks such that workload between DMs would be evenly distributed and minimum coordination would be required between nodes. Figure 8 shows the organization structure and ownership of assets for the nontraditional organization. In the NTA organization, DM 0 would again equate to the CJTF, but the other DM's do not fit any of the current military component terms; they are unique in their structure.

c. *Differences Between The Traditional and Nontraditional Architectures*

Figures 7 and 8 show the command relationships between the DMs in the TA and NTA organizations. At first glance, the architectures do not seem to be significantly different. Closer examination of the NTA structure shows that "jointness" of the organization has been pushed to the next lower echelon in the chain of command when compared with the TA structure. This is similar to current military thinking. Recent technology advances are obviating much of the interoperability problem in communications between the services, permitting joint operations commands to be inserted into lower echelons of joint operations while also permitting flattening of the organizational structure, thus increasing the overall responsiveness of the command.

2. Total Asset Determination

To eliminate another factor in the design of the experiment, both organizations (TA and NTA) were assigned the same number of units and platforms, with the same combat potential, to achieve the same tasks and complete the mission. We desired to ensure sufficient resources with associated capabilities were provided to the organizations to accomplish the mission before and after the triggers and to ensure that both organizations were required to coordinate both internally and externally. Therefore, it was necessary to perform an iterative process, closely integrating asset design with the scenario and trigger design efforts to determine the proper quantities and capabilities of the assets. It was necessary to define/refine platform resource vectors and task attribute vectors (Explained before) to:

1. Require coordinated action by two or more units/platforms to accomplish mission tasks.

2. Ensure that more than one combination of platforms could be used to accomplish mission tasks.

3. Ensure sufficient assets were provided to accomplish missions before and after the triggers were invoked.

4. Organize task forces into capable subordinate elements.

5. Organize overall mission into manageable parts.

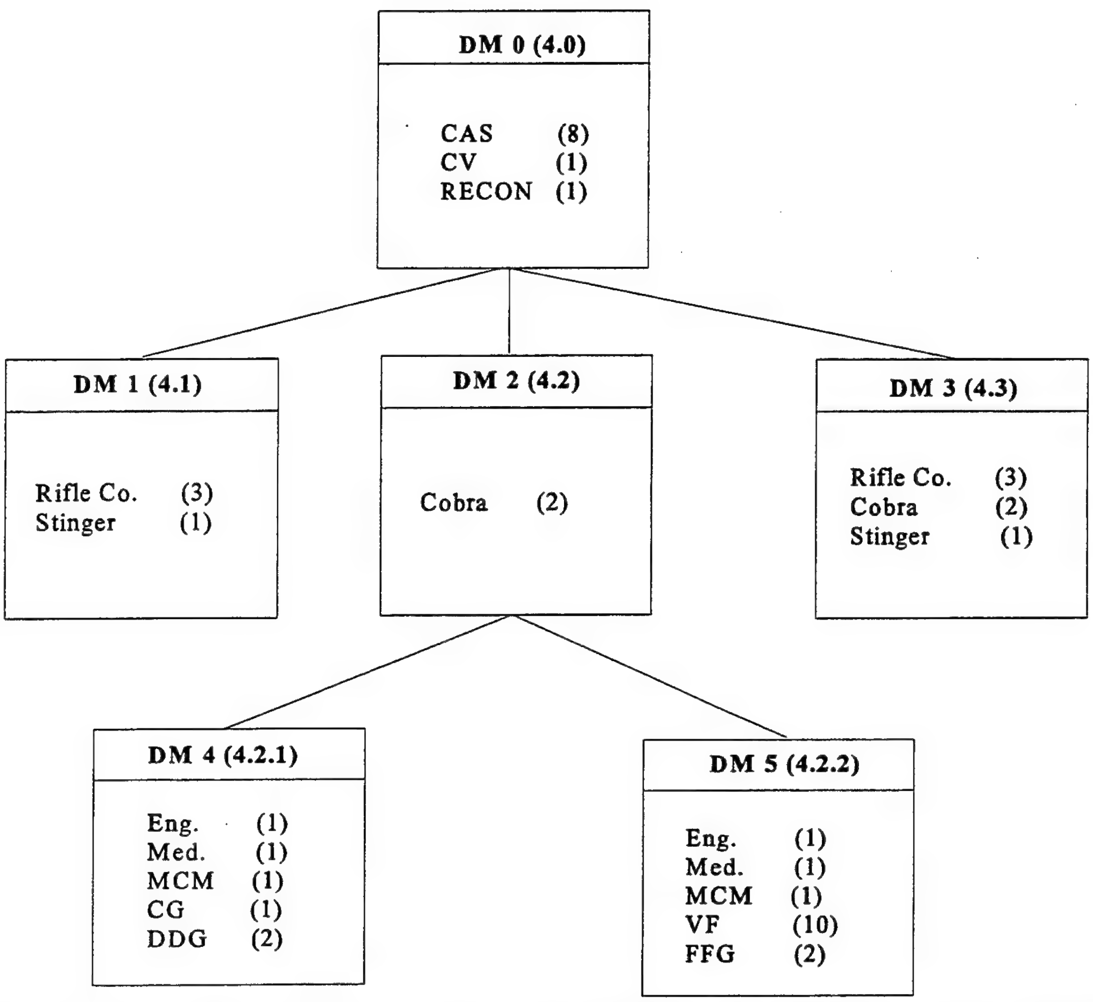

Figure 8: Nontraditional Architecture (same as Figure 6, provided here for convenience)

G. CONDUCT OF EXPERIMENT

An overview of the experiment including the facilities, equipment, lead team, players, and training is provided in this section. Most of the equipment and facilities were the same as used in experiment one.

1. Experiment Setup

The second NPS A2C2 experiment was conducted in the secure Systems Technology Lab.

a. Physical Facilities

The scenario was presented to the player teams on a distributed, interactive, computer simulation running on seven SUN SPARC™ model 20 workstations (one for each of the six DMs and one for the DDD-III controller's station). The Systems Technology Laboratory at the Naval Postgraduate School in Monterey, CA was utilized for conducting the experiment. It provides an area where access is controlled so interrupts and disturbances are minimized. Although all players from a team were located in the same room, dividers were placed between them to physically obstruct their views of the other players' screens. Communication among players was restricted to preformatted computer messages built into the simulation and recorded voice communications over two separate channels connected to common headsets. The ability to communicate between DMs is an important factor affecting organizational structure and coordination of efforts. DM nodes in an organizational structure represent the

decision makers or commanders of the resources that are responsible for completing assigned tasks in the overall mission. For the purposes of the experiment, "stovepipe" C4I systems have been eliminated in the scenario and all DMs easily communicate with each other by voice or electronic messages.

b. *Lead Team*

A group of nine NPS officer students from the Joint C4I Systems Curriculum in their last year were designated as the "lead team" for this experiment. The lead team was composed of officers from all four branches of the armed forces. In addition, all members had recent operational experience. Since I had been involved as an associate researcher on the A2C2 project for the past year, I headed the lead team.

The lead team performed such tasks as preparation of training materials for the subjects, conduct of subject training, setup of the physical space, debugging the simulation, piloting the scenario's implementation in the simulation, conduct of the experimental runs, and data collection. The lead team members provided invaluable suggestions and advice concerning all of the above tasks, developing the scenario, and filled many gaps in the author's experience.

c. *Test Subjects Used*

The test subjects were 23 military officer students from the Joint C4I Systems and Space Systems Operations Curricula plus a recent graduate from NPS. The subjects were organized into six four-person teams with two confederates rounding the

teams up to six. The confederates were three members of the lead team who augmented the player teams. The confederates were used to perform the functions of one of the DMs at each of the two lowest echelons. By using the confederates, we were able to form six-player teams from the 24 subjects. The teams were formed by the experimenters with participants distributed according to military occupational/war fighting specialty and branch of service, to the extent that was possible given the demographics of the sample. Table 6 shows the composition of the teams by branch of service, type of service (operational or support), and curricula Since there was a fairly significant difference between the operational experience of the subjects, the experimenters were concerned that some subjects would be more familiar than others with the appropriate tactics to employ in a given situation, and that this might bias the performance measures chosen as dependent variables. In order to help protect against such an effect, the scenario and the operations orders were tailored to facilitate a step-by-step approach to each situation. This approach further aided the experimenters' attempt to steer the subjects toward the coordination events that were of primary interest in the experiment.

d. *DDD-III Simulation*

The experiment was conducted using the Distributed Dynamic Decisionmaking-III (DDD-III) paradigm simulation. Earlier variants of the DDD had been used extensively to study decisionmaking in the Navy's Composite Warfare Commander (CWC) organizational structure and civilian sector organizational experiments. Last year DDD was extended to fit the general requirements of tier-I experimentation for the A2C2 project, and was further enhanced to meet the specific

requirements of the current experiment. DDD is not a tactical model on the level of RESA, JTLS, MTWS, CBS, or AWSIM which are driven by extensive and detailed parametric databases. DDD is a more abstract game that uses performance and resource vectors to describe entity capabilities at a higher level of abstraction. The result is a simulation that appears to operate like the combat event simulations above, but is easier to use to develop scenarios and requires a much shorter time to train subjects. DDD-III contains data collection and variable manipulation capabilities that make it very appropriate for a research environment. For a more detailed explanation of DDD-III, including characteristics, see Higgins (1996).

Team A	Team B	Team C	Team D	Team E	Team F
NOC	NOC	NOS	NSS	NOS	NOS
AOC	FSC	FSC	NOS	MOS	NSS
MOC	MOC	NOS	NSS	NSS	NSS
NSC	NOC	NOO	NSS	NOS	NSS
Legend For Table					
Code #	Factors	Meaning of Codes			
1	Branch of Service	N = Navy A = Army F = Air Force M = Marine Corps			
2	Type of Service	O = Operational S = Support			
3	Curricula	C = C4I S = Space Systems Operations O = Ops Research			

Table 6. Composition of the Teams of Players for the second NPS Experiment

e. *Matching of Subjects to Task/Organizational Structure*

The research team wanted to assign the subjects to a particular node at each level of hierarchy in the organizational structures throughout the training and data runs; if a subject began the training runs as the CJTF for his team, for example, he would remain CJTF throughout the experiment. In addition, it was desired to keep the subjects involved at each level in of the hierarchy in the organizational structures. To facilitate this requirement, the confederates were assigned to DM 1 and DM 5 nodes in the traditional organization and to DM 1 and DM 4 nodes in the nontraditional organization.

To the greatest degree possible, the experimenters and lead team attempted to match the subjects to positions in the organizational structure for which they had some operational experience.

2. Operationalization of Task/Organizational Structures

The organizational structures and the task structures were operationalized in three significant respects: asset structure, communications structure, and information structure.

a. *Asset Structure*

The scenario was.designed so that some tasks (coordination events) could not be successfully performed with a single asset. The assets required to perform a task requiring a coordinated attack may belong to one or more DMs. Unlike experiment 1, assets could not be transferred between DM's in this experiment. Instead the DM initiating the attack must coordinate the attack with resources he owns or he must coordinate with other DMs to successfully perform the task. For example, if MEU 2 was attacking the beach and required support, the experimenters wanted MEU 2 to request support from the necessary asset (the DDG) to shell the beach, rather than allowing the

DM owning the DDG to transfer it to MEU 2. This was enforced by DDD-III to ensure that the external coordination events actually occurred. Table 2 shows each platform's resource or combat potential vector and the task attribute vector (enemy force combat potential) required for a successful attack.

b. Communications Structure

Communications in this experiment consisted of preformatted messages and data transfer using the DDD-III simulation and two channels of open voice communications. Open communications were allowed between all DMs, simulating the projected future integrated C4I systems ability to provide a common operational picture (COP) as described in the next section.

Copies of all messages sent by a decisionmaker were automatically forwarded to the next higher level in the sender's hierarchy. If a lower-level unit communicated with another low-level unit, copies of the messages were automatically sent to the intermediate commander in his chain of command. If the intermediate level commander communicated with a lower level unit, a copy of his message was automatically forwarded to the CJTF.

Both voice channels were open so that all DMs could monitor all communications. The recommendation to the subjects was to have one channel for all routine communications and the other channel be used by DMs who were coordinating an attack.

c. Information Structure

One of the major assumptions for this experiment is the existence of a common operational picture (COP) and a fully integrated communications network which allows all commanders at all levels to have a common view of the battlespace; they see the same threats, at the same time and can easily and readily communicate up, down, and across the chain of command. Since our purpose was to test organizational structures in a future environment of shared, global information, the COP was implemented in our experiment. When one decisionmaker in the organization saw a threat or task, others saw it too. To provide identification of a target, the DM whose sensors held the contact had to fuse that information into the COP by sending it to the other DMs.

3. Training

The proper training of the subjects in the operation of the simulation and the requirements of the operations order (OPORD) was vital to the success of the data runs. Two aspects of this training were significant: the training materials that the lead team and experimental team generated, and the conduct of the training itself.

a. *Training Materials*

Three primary training aids were developed for the experiment: an operational order (OPORD) which transformed the scenario into a directive for execution of the operation, a tutorial designed to aid the subjects in using the DDD-III, and the scenario developed for the training portion of the experiment.

(1) Operations Order: When a military operation or exercise is conducted, an OPORD is issued as a directive listing mission requirements including resources,

threats, constraints, and options. This OPORD provides the unit(s) that will conduct the mission the general situation, enemy forces, friendly forces, assets available, the mission requirements, how the mission will be executed, logistics, and command and control information. This was the format used to provide the subjects the information needed to execute the scenario.

(2)Tutorial: The tutorial provided the link between the OPORD and DDD-III. It described the simulation, its display and user interface, functions of the mouse, requesting, launching, moving and transferring assets, identifying and attacking threats, and use of the communications system to view, send, and receive messages. The tutorial listed and described in detail the objects that appear on the DDD-III screen, including terrain features, and provided a description of the organization structures used in the experiment and how they are implemented in DDD-III. A quick reference sheet was provided that concisely described all the objects on the screen and possible asset combinations that could be used to destroy enemy threats, abbreviations used by DDD, a list of assets, and the platforms on which they were carried.

(3)Training Scenarios: The training scenarios were devised to help the subjects learn about the simulation and OPORD, and allow them to become proficient in the skills that would enable them to successfully complete the mission and coordination efforts during the trials. The experimenters did not want to overload the subjects during the training phase, so the training scenarios were devised with a lighter workload. These scenarios were written by the author, with advice and assistance from the lead and experimental teams. Two scenarios were provided so that the players could not anticipate

upcoming tasks and events in the actual trial runs and preposition assets to accomplish them.

b. *Conduct of Training*

Initially, the subjects were given a one-hour briefing in a classroom so they understood:

- They were taking part in an experiment (no experimental objectives or other compromising details were divulged).
- The OPORD and the organization structures they were assigned; teams were assigned organizational structures, TA or NTA. Teams were briefed separately for experimental control purposes. They did not know there was any difference in the organizational structures they were assigned.
- The DDD-III simulation.

The purpose of this brief was to give the subjects only a general overview of what they would be doing during the training periods and the experiment trials and to give them some context for the training runs. The training runs were then conducted as previously mentioned, using the training scenarios which contained no trigger events, but in aggregate, had a requirement for all of the subjects to use all the assets within each component. During the training runs, four members of the lead team were present to assist each team of subjects in familiarizing themselves with the simulation and OPORDER. The training runs were also used by the research team members for training

the lead team observers. The training was conducted in two one-hour blocks, running each team through two different scenarios. During the first training session the observers and confederates provided instruction to the teams, stopping game time as needed. During the second hour of training, to more closely prepare teams to deal with the pace of activities during the trials, game time was not stopped.

4. Experiment Setup

The experiment was conducted during 12 to 22 November 1996. Observer and confederate training was conducted to prepare the lead team-members for their parts in the experiment and re-familiarize them with the DDD simulation. The observers were to monitor team performance during the trial runs, provide buttonology assistance to the players as necessary, control the video recorder, act as DDD-III simulation controllers, and take notes to help evaluate team performance and communications. Observers were also used during the planning sessions to distribute and collect the data packages, keep the teams focused on the planning process, and run the video recorder. They were also available to answer any questions the teams had about the requirements and data collection questionnaires.

The confederates assisted the players in training during the first training run, then acted as regular members of the team.

The experimental trials consisted of three two-hour blocks for each of the teams. Each team completed the two training runs described above during the first time block. The second time block consisted of the first trial run and a "planning session", in which the teams were asked to evaluate their assigned organizational structure (TA or NTA) and

propose any organization structural changes they wished to make which would improve their ability to complete their mission more effectively. The third time block consisted of two one-hour planning sessions. At the start of the hour, the teams were presented with one of the two ORDMODs; a NEO which either adds another mission and set of tasks to accomplish in addition to the current mission, with the same resources, or a loss of approximately one-third of the resources to accomplish the same mission. The teams reviewed their ORDMOD trigger, then developed an organizational structure they would use to conduct the mission.

Data was collected during all three runs of the DDD simulation by the lead team observers and the members of the experimental team. The two training runs in the first time block and the data collection run were each 40 minutes long. The remaining three hours per team were used as planning sessions and survey and interview periods for the subjects. These periods were used by the lead team and other observers to collect data from the sessions. At least three members of the lead team, in addition to the lead team confederates, were present at all times during the six hours of training, trials, and planning sessions to monitor the subjects, take observation notes and collect data.

H. SUMMARY

How the task design process described in Chapter III was implemented for the second NPS experiment is described in this chapter. First, the experimental designers determined the task structure dimension of interest and required structural characteristics, similar to the tasks used in the previous experiment and research. Next, I iteratively

developed a scenario, using the task structure description paradigm generated in Chapter III, that complied with the experimental designers' requirements. This was done within the constraints of the dimensions of task structure defined in Chapter II. The organizational structures used in the experiment were then developed and checked to verify structural differences, and OPORDs and ORDMODs were written. Finally, the conduct of the experiment was described, including a closing discussion of the scenarios and organizational structures that I helped design.

Chapter V will include a brief overview of some of the preliminary findings from the data. Chapter VI will contain a discussion of the lessons learned from the experiment with regard to scenario design, and from the above implementation of the scenario design process, as well as some of the modifications and improves to the DDD-III simulation. Chapter VII will be a summary of the issues discussed in this thesis.

V. PRELIMINARY FINDINGS

Preliminary analysis of the data from NPS experiment two provided some interesting results. This is beyond the scope of my thesis, but an overview of findings based on preliminary data analysis by members of the NPS research team provides continuity and background for future research areas that I mention later in Chapter VII.

A. DATA

Data was collected from various sources and through different methods; this would provide a limited cross check on data despite the small sample size available. Data was collected through use of the DDD simulation, observers from the lead and research teams, video recordings, and questionnaires completed by the players. The data that was collected consisted of:

DDD log files - Files from the DDD-III simulation recording actions by each DM during the DDD-III runs.

Organizational Charts (command, communications) - These are charts and graphs developed by the players during the planning sessions which delineated the chain of command and communication connectivity that would exist in their proposed organizational structures.

Asset ownership, functional allocation - Developed by the players during the planning sessions to describe the physical structure of their proposed organizational structure.

Preliminary task graphs - Developed by the players during the second and

third planning sessions (sessions with triggers) to explain their intentions and plans for completing the mission as modified by the trigger events.

Post-planning questionnaires - Completed by the players at the end of each planning session to solicit additional information from the players about their evaluation of the effectiveness the organizational structures and adaptation.

Observer data - Notes taken by the observers evaluating team and player performance during the DDD-III runs and the planning sessions.

Video tapes of the DDD runs and planning sessions - Video recordings of the DDD-III runs and the planning sessions were taken. The videos of the DDD-III runs provided a copy of the voice communications. The videos from the planning sessions provide the research team with an unobtrusive method of observing the thought processes of the teams during the planning.

B. PRELIMINARY FINDINGS

The following overview of preliminary findings is not official and is biased by my personal thoughts and observations from the experiment. The final findings of the entire research team after completing a detailed analysis of all the data and modeling evaluations may be significantly different.

After the training and trial runs on DDD, the teams were given the opportunity to change their organizational structure to perform the same mission. Teams were given a structured planning sheet and their initial organizational structure as the starting point. Although no team kept their initial organizational architecture as played on DDD, no team

started from scratch. Instead they all "edited" their starting architectures (TA or NTA) to design their new organizational structure. All teams made incremental changes to architectures that they were apparently "comfortable" or familiar with.

- The three traditional architecture (TA) teams submitted hierarchical (3-Level) architectures that were essentially a "pruned" traditional structure, while the three nontraditional architecture teams submitted flat (2-Level) architectures derived from their starting architecture. Although the teams were instructed to design a six node architecture, after trigger two, four of the six teams wanted organizations with less than six nodes.

  In order to determine if these are "results" or just artifacts, a more complete analysis is in progress.
- While both organizations had a similar workload at the DM 0 level, the traditional architecture generally outperformed the nontraditional architecture on mission performance subtasks, with "mission" scores averaging 96% versus 85.3% even though the nontraditional architecture required (and showed) fewer inter-DM coordinations on mission performance subtasks.
- The traditional and nontraditional architectures performed about the same overall on defend and encounter tasks. These invariably were done by a single DM in both organizations.
- The traditional architecture was better at suppressing ground threats while the nontraditional architecture appears to have been better at ASW and ASUW defense.

- There is a strong linear correlation (R = 0.95) between rated teamwork and the computer generated performance score, but I do not know if this is a rater phenomenon or an indicator of "better" teams? (Did the observers note the higher performance scores and then rate the team work higher?)
- For some tasks, the rated performance does not agree with actual performance as recorded by the DDD simulation. There are several instances where the observers consistently rated the TA teams as "better" in performing specific tasks yet DDD log files show there was no significant difference in TA and NTA performance scores for these tasks. This may indicate some amount of the "halo effect" influencing an observer's rating of a team.

Although the dimensions of task structure and the task structure diagrams based on the scenario for the trial runs were identical or nearly so, the resource allocation within the assigned organizational structures (TA and NTA) was significantly different. This fundamental difference in the resource allocation assigned to the TA and NTA organizational structures required, in my opinion, a far different mind set on the part of the players in each architecture for the conduct of the overall mission, and negatively affected the nontraditional architecture players' initial performance. This was apparent in the much steeper (larger rate of change in performance scores from one trial to the next) learning curve exhibited by these teams. It is my belief that, the human "comfort level" or familiarity with the situation/organization significantly influences the efficiency and effectiveness of joint operations. This problem is correctable and must be factored into joint training and doctrine for joint operations and experiments.

1. Traditional Architecture (NPS)

All 3 teams kept the same (3-tier) structure(s) except for attempts to tie CAS more tightly to the rifle companies (DM 4 and DM 5) (e.g., assign CAS to DM 1 and DM 3, or establish separate cells in DM 2 to coordinate with DM 4 and DM 5).

The traditional architecture teams felt that the allocation of resources for their initial organization was more "realistic" than the nontraditional teams. (Perhaps what we are used to is considered more "realistic".)

2. Nontraditional Architecture (Model-Derived)

Although all three teams selected a flat (2-tier) structure with some reallocation of assets, there was no consistent pattern across teams to the changes in asset allocation in the new architectures (perhaps because of a lack of experience, training, and doctrine to guide them, they were taking their "best shot" at improving their performance). Two of the teams allocated CAS to node DM 2 which was underutilized in the original nontraditional architecture.

C. CONCLUSIONS

An in-depth analysis of the data still needs to be completed. The initial findings that I presented in this chapter may not endure the full analysis by the A2C2 team. However the preliminary analysis of the data by the NPS research team indicates interesting results concerning human influence on organizational adaptation are possible.

VI. LESSONS LEARNED AND MODIFICATIONS AND IMPROVEMENTS TO THE DDD-III SIMULATION

Upon completion of NPS experiment two, the observations of the A2C2 researchers and lead team members made it clear that there were ways to improve the design of experiment, task design process, and the data collection methods for future experiments. I focus here on the items of interest in my thesis, the task structure and scenario development and enrichment process.

A. LESSONS LEARNED FROM THE SCENARIO DEVELOPMENT PROCESS

Following the completion of NPS experiment one, the experiment team received complaints from the players about the lack of realism in the scenario. Significant efforts went into improving the simulation and the scenario to correct this shortcoming, but there is still room for continued improvement.

1. Tradeoff Between Realism and Coordination

There are three main areas where complaints concerning realism in the second experiment occurred; limited capability of the assets, rigid task performance sequencing, and "non-thinking" troops or the lack of "smart" forces. I will discuss these in more detail in the following subsections.

a. Limited Capability Assets

Based on the criticism concerning realism received from subjects in NPS experiment one, many changes were made to make NPS experiment two more realistic.

However, criticisms concerning the scenario's lack of realism were still received from the subjects of experiment two as well, but to a lesser extent. Realism tradeoffs is a complex issue that I addressed during the design and development of the scenario for experiment two. There is a balancing act between realism and control of experiment issues. To induce DMs to coordinate resources to complete complex tasks with other DMs, scenario events were introduced in a consistent, reproducible manner. The scenario forced the coordinated use of multiple assets owned by multiple DMs to perform certain tasks. This resulted in some unrealistic restrictions since military platforms can usually conduct more than one operation/evolution at a time and are capable of engaging more than one target at a time. A scenario design that allowed the assets to more accurately reflect the real world would have allowed the teams to create their own task structures and avoid entirely the coordination events that were the focus of the experiment. Enhancements to DDD which will enable multiple target engagements by some of the platforms are being investigated for use in future experiments.

b. *Hard Prerequisites*

Designing the implementation of the scenario in the simulation so that certain activities must be performed before others (hard prerequisites) is helpful for ensuring that a team follows a desired task structure. Like the design of limited capability assets, development of hard prerequisites impacts the level of realism. The value of strictly following a desired task structure for experiment control purposes must be balanced against the value of allowing a team to make mistakes or solve problems on its own. This issue is also intertwined with DDD training, operator training, doctrine and experience level, and the

TA and NTA organizational architectures. Since the focus of this project is adaptation of organizations rather than innovative problem solving, hard prerequisites work to our advantage and will remain a part of the experimental design.

c. *"Smart" Forces*

In the current version of DDD, forces will continue into a hazard even after it has been identified unless the DM who owns the asset halts it. No message or warning is given to the DM, so if he isn't focused on that area or asset, he won't recognize the hazard (task), and performance points are lost. An enhancement to DDD that causes forces to stop when a hazard is encountered and send an alert message to the DM is being investigated. This may prove beneficial to the experimenters in several ways besides increasing realism. Fewer assets (tasks) will be "lost" due to inadvertent encounters, and the communications "noise" level (load level) will increase.

2. Task Spawning

The use of task spawning, where completion of a specific event or action triggers another task or event, allowed an additional degree of realism in the DDD simulation. The actions of the DMs are used to activate a task rather than activating tasks simply based on game time. For example, in the second NPS experiment, the attack on the hill triggered enemy air attacks. In the first NPS experiment the background tasks and obstacles appeared based on game time, whether the friendly forces had initiated any actions or not.

B. LESSONS LEARNED FROM CONDUCT OF THE EXPERIMENT

During the conduct of the experiment and initial analysis of the data, it was apparent that there were several areas where the design and implementation of the experiment and data collection methods could be improved.

1. Use of Confederates

The manner in which the use of confederates in the two organizational structures was implemented was the source of some difficulty. First, there were only three confederates so they be alternated between teams and positions. While the same confederates remained paired with a team, they didn't remain paired with each other or always play the same position. This resulted in some differences in the interactions between the DMs as a result of personality issues. The use of only three confederates was based on limited people in the lead team and scheduling constraints. The design team had felt that it would not have any significant impact on the results, but post-experiment analysis of the data revealed that some of the confederates had significantly more input during the scenario than others. If confederates are used in future experiments, I recommend keeping them paired with each other and filling the same DM positions each time to control individual DM effects throughout the experiment. If a pair of confederates is treated as a unit "personality", using four confederates would allow two confederate pairs to be formed instead of the three confederate pairs required using only three confederates.

2. Increase Time Pressure

Additional time pressure (workload) would have improved the experiment. Several of the teams in experiment two operated under a reasonable amount of time pressure. The other teams, composed of more operationally proficient members, appeared to work under relatively low time pressure while accomplishing the same tasks. The more operationally proficient teams tended to score well based on performance measures independent of workload (Noted in scores during training runs and experiment run), making it difficult to find any difference between the time pressure (workload) factor levels. A solution is to increase time pressure by increasing the workload rate. This is achieved by increasing the number of activities (subtasks) within the scenario or increasing the quantity and complexity of the coordination events. Increasing the clock time rate of the simulation is not a good option, when the clock time is increased, the screen display graphics do not keep pace with the objects' actual positions in the data files and it becomes difficult to "tag" moving objects for attack or identification.

3. Increased Number of Coordination Events

Increasing the number of coordination events by enriching the scenario with other assets, tasks, and background events results in more data points for analysis. This must be accomplished in such a way that the overall run time of the scenario is not significantly increased (40 minutes). If scenario runtime becomes too long, the number of replications (sample size) is reduced due to the fixed, limited time the players have available for the experiment.

4. Team Formation

The varied operational experience level of the officers performing as subjects in NPS experiments continues to be a challenge. Officers with significant operational experience more easily adapted to the scenario and tended to perform better than their classmates with less experience. Performance variance due to experience made it difficult to attain a reasonably constant level of difficulty across teams and individuals, but just the opposite is desired for control purposes (keep everything as constant as possible across the trials by design of the experiment and counterbalancing to neutralize differences between teams). This factor may become more pronounced as A2C2 experiments progress toward more realism with higher command levels and more senior players. This must be addressed as we continue to gather additional knowledge of adaptive command and control architectures in a joint operational-level context. In real world operations, this problem would hopefully be eliminated or mitigated by training and doctrine as well as by competent staff members to provide advice and recommendations.

Officers who were operationally experienced, but played a role in the experiment outside of their area of expertise, did not tend to function as well as their subordinates who were in their area of expertise.

While readily apparent in the small subject pool used in the A2C2 experiment two, it may contribute to the realism of the results. All the officers assigned to a task force will not have the same level of expertise and capability. The organization must determine the best use the assets that are allocated to it, human and equipment.

5. Data Collection Methods

Data collected in the planning sessions tended to be more qualitative or subjective than quantitative; this made analysis of the data more challenging. Frequently the analysts made judgement calls based on the subjects' statements.

More detailed piloting and testing of the data collection forms and questionnaires is required. A thorough review by persons uninvolved with the original draft of these documents would be very helpful. Questions that I thought were straightforward and obvious were actually ambiguous in many cases depending on the respondent's level in the command structure.

a. Data incomplete and/or inconsistent

The subjects and observers did not have sufficient time to complete an analysis and planning session and fill out the required forms. I thought the essay type questions used as part of the data collection forms would yield the most data, providing more insight into the thought processes the players used to arrive at their answers, and allowing the widest range of answers. Due to the limited time available for planning, reaching a consensus among the team members, and filling out the forms resulted in answers that were incomplete, hard to read, and inconsistent within a team. Post-experiment analysis required "experts" to fill in gaps or interpret the answers. In many cases it was necessary to go back to the video tapes of the planning sessions to resolve ambiguities and inconsistencies in the written answers. Use of multiple choice questionaires, checklists, and spreadsheets to obtain asset-to-DM and DM-to-task allocations may be helpful to mitigate these problems in the future. Other recommendations to improve the usability of the data would be to immediately follow-

up planning sessions with semi-structured interviews or to have the designated CJTF brief and defend the (re)organization to the Commander-in-Chief. Significantly more time is required to extract and analyze the data from oral interviews, and the interviews would require additional time from the subjects, either reducing the time available for DDD runs and planning sessions or increasing the amount of time per team to complete their trial.

C. SUMMARY

While it is desirable to approach the operational environment as closely as possible during the experiments, this must be balanced against the need for control of the experiment. While it may be necessary to introduced some artificialities into small scale experiments to ensure the phenomena that are being investigated occur, it is imperative that the artificialities be introduced/implemented in a way that does not alter the phenomena themselves.

Chapter VII will be a summation of the paper and will present some short term research areas for future experiments.

VII. THESIS SUMMARY AND FUTURE RESEARCH PLANS

The A2C2 project is an ongoing research effort, building on the data collected and the lessons learned in each experimental cycle. The preliminary findings of the data from NPS experiment two have piqued the interest of ONR and the research teams in several additional areas. I summarize my thesis, then list some of the short term future research areas for follow on experiments.

A. SUMMARY OF THESIS

This thesis was conducted as a part of the Adaptive Architectures for Command and Control (A2C2) research project, which seeks to explore how teams adapt in reaction to changes in resource availability and mission caused by internal and external triggers. The project's second NPS experiment involved studying interaction between resources and task structures and organizational structure and the resulting adaptation of organizational structure.

This thesis describes a process for developing military operational scenarios within a task structure context. First, I conducted a review of Michael Berigan's work [Berigan, 1996] which defines the dimensions of task structure applicable to this project, develops a grading scale for each dimension, gives examples of the dimensions and grades each example, and describes how changes in one dimension might affect other dimensions. Then a method for developing scenarios in accordance with a predetermined structure and visualizing tasks is described, including a task structure diagram and a description of a task design process using

the diagram and the dimensions previously delineated. I then apply the task design process by developing scenarios and organization structures for the experiment that allow an evaluation of the interactions between task/mission and organizational structure across one dimension of task structure, *coordination requirements*. Finally, a description of the experiment is given, including discussion of the scenarios and organizational structures, preliminary findings, and lessons learned from the experiment with regard to scenario design.

B. FUTURE RESEARCH AREAS

Research efforts will continue to focus on the concept of adaptation. The first phase of the A2C2 project developed joint C2 scenarios, investigated the mapping of tasks onto architectures, and studied structural and architectural variables and their effects on organizational performance and began looking at adaptation. The next step in the A2C2 research effort will focus on the investigation, both theoretically and experimentally, of the variable of adaptation. The next phase of A2C2 research will focus on:

- Identifying and understanding the decision of organizations to adapt their organizational structure.
- Understanding the consequences of adaptation in terms of organizational processes and performance.

An area of high interest is the concept of incremental organizational changes as opposed to sudden drastic switches in structure. Several sources in the organizational theory literature argue that organizations resist radical changes to their structure even when changes in the environment warrant a drastic change. This is particularly true after having performed

well under a given architecture. In other words, human organizations may prefer familiarity or robustness of performance across a wide range of tasks and resources to optimality of an organizational structure to one specific mission.

For a more detailed look at proposed research, see Adaptive Architectures for Command and Control (A2C2) Research Plans (Version 1.1), June 1997, by Daniel Serfaty of Aptima, Inc.

APPENDIX A. OPORDER's, ORDMOD's, AND QUICK REFERENCE SHEETS

Appendix A contains the OPORDER's for the TA and NTA organizations, the ORDMOD's for the noncombatant evacuation operation (NEO) vignettes (one adding tasks to the mission, the other taking assets away from the organization), and the quick reference sheets which were provided to the players.

IMMEDIATE TA

FROM: USCINCMED NAPLES IT
CJTF FOUR

TO: CJCS WASHINGTON DC
USCINCCENT MACDILL AFB FL
USCINCLANT NORFOLK VA
USCINCEUR VAIHINGEN GE
CINCFOR FT MCPHERSON GA
USCINCPAC HONOLULU HI
USCINCTRANS SCOTT AFB IL
USCINCSTRAT OFFUTT AFB NE
COMMARFORPAC HONOLULU HI
CINCPACFLT HONOLULU HI
JTF FOUR

INFO: WHITEHOUSE SITUATION ROOM WASHINGTON DC
SECSTATE WASHINGTON DC
SECDEF WASHINGTON DC
CSA WASHINGTON DC
CMC WASHINGTON DC
CNO WASHINGTON DC

DISTR: CINC/DCINC/CCJ1/CCJ2/CCJ3/CCJ4/CCJ5/CCJ6

FOR OFFICIAL USE ONLY
OPER/THUNDER SPEAR//
MSGID/ORDER/USCINCCENT//
AMPN/SPECIAL HANDLING INSTRUCTIONS
REF/A/ORDER/CJCS/011742Z NOV 96//
REF/B/ORDER/CJCS/041142Z NOV 96//
NARR/JT STRAT CAP PLN (FY 96), CJCS ALERT ORDER//
ORDTYP/OPORD/USCINCCENT 11-96//
MAP/1015/TUNSIA//
MAP/1020/Yang//
NARR/SCALE 1:100,000//
TIMEZONE/Z//

HEADING/TASK ORGANIZATION//

UNITS

/UNITDES	/UNITLOC	/CMNTS
/USCINCLANT	/NORFOLK VA	
/USCINCEUR	/VAIHINGEN GE	
/CINCFOR	/FT MCPHERSON GA	
/USCINCPAC	/HONOLULU HI	
/USCINCTRANS	/SCOTT AFB IL	/2 TAC ARLFT SQ
		/6 KC-10
/USCINCSTRAT	/OFFUTT AFB NE	/2 RC-135
/COMMARFORPAC	/HONOLULU HI	/1 MEB
/CINCPACFLT	/HONOLULU HI	
/HQ USMEDCOM FWD		/(JTF 4)
/HQ USMEDAF (MINUS)		
/HQ USNAVMED (MINUS)		
/SUPPORTING FORCES		
/COMSUPNAVFOR		
/MPS//		

GENTEXT/SITUATION

1. (FOUO) Yang has attacked the friendly nation of Ying. Attacking forces have succeeded in seizing Yingian port of Plethora. Yingian government has requested U.S. assistance in taking back port of Plethora and driving Yangian forces from Ying.

A. (FOUO) ENEMY FORCES

1. (FOUO) See current SITREP and DIN. Port of Plethora protected by obstructions, mines, obstacles, and the presence of hidden enemy among the port facility buildings. Two beaches approx. 5 miles south of the port may be suitable for amphibious assault. Northernmost beach (designated "Red Beach") has road leading to the port. Southernmost beach (designated "Blue Beach") has a road leading to the airfield. Waterborne approaches to the beaches are possibly mined. Commanding terrain to north of Red Beach believed occupied by enemy Heavy Mortar Platoon with a platoon of Infantry for security. This terrain dominates both Red Beach and the port. Seizure and retention of this dominant terrain should be considered essential for successful attack on Red Beach and port.

(2) (FOUO) Believed to be at port, but hidden from view, is company-sized armored counterattack force that could move toward Red Beach in response to any amphibious assault. Similar counterattack force may exist at airfield, which is located about 5 miles inland from the Blue

Beach. These counterattack forces could inflict serious damage if not interdicted before they reach either beach. Off-road terrain between beach, port, airfield, and commanding terrain is swampy and treacherous; and is unsuitable for travel. Thus, all travel must be on the two roads. It is believed that one or both of the roads will be mined. Locations of any minefields are currently unknown. Port, airfield, both roads, both beaches, and commanding terrain are located within range of artillery strong-points. Northernmost strong-point can range Red Beach and port. Southernmost strong-point can range both Blue Beach and airfield. Artillery pieces are housed in reinforced concrete bunkers, with ammunition stored in deep underground bunkers. It is unlikely that even concentrated air attacks will completely disable the artillery strong-points. Enemy can be expected to wheel out artillery pieces (from 8 to 24 at a time), set up, sight in, and fire within 5 minutes. If friendly forces can get effective NSFS on target in less than 5 minutes, the enemy will most probably wheel their artillery pieces back into bunkers and wait until another time.

(3) (FOUO) Enemy also has several Frog Missile Launchers known to be capable of carrying chemical munitions. Frogs believed to be hidden in the vicinity of both artillery strong-points. They can emerge from covered positions, prepare warheads, and fire missiles within 10 minutes. Past experience has shown that Frog crews are more stalwart than artillery crews. They will continue to prepare and launch their missiles even if they are being suppressed by NSFS or artillery.

(4) (FOUO) Submarine threat is considerable. Enemy has at least one Alfa-Class submarine known to be in the area, and possibly more.

(5) (FOUO) Enemy possess HIND Helicopters, which have demonstrated the capability to launch anti-ship missiles. The DDG, CG and CV possess capabilities to counter these helicopters.

2. FOUO) The enemy has significant air strike capability, and can launch anti-ship missiles from most of its strike aircraft.

(7) (FOUO) The enemy's Special Forces also possess numerous fast patrol boats, that can either fire very potent Russian torpedoes or be loaded with explosives for suicide missions.

(8) (FOUO) There are Silkworm threats throughout the area. The Silkworm missiles are placed in residential neighborhoods because they know U.S. will be reluctant to target residential areas. Accordingly, if U.S. warships want to target a Silkworm launcher, they must first get visual confirmation of its presence, using theater RECON (TARPS) assets, and any strike must use precision guided munitions.

B. (FOUO) FRIENDLY FORCES. JTF 4 will be comprised primarily of assets organic to Mediterranean Command (MEDCOM). A theater-level JFACC and other friendly forces are operating against the enemy in Ying, but not in concert with the JTF.

3. (FOUO) JTF 4 will consist of one RECON (TARPS), and subordinate units (4.1, 4.2, 4.3, 4.1.1, 4.3.1).

4. (FOUO) JTG 4.1 will consist of one DDG, one LPD, two Cobra Sections, one Huey MEDEVAC, and one MH-53 MCM.

(3) (FOUO) JTG 4.2 will consist of one CV, one CG, two FFG's, eight Fighter Sections, and eight CAS Sections.

5. (FOUO) JTG 4.3 will consist of one DDG, one LHA, two Cobra Sections, one Huey MEDEVAC, and one MH-53 MCM.

(5) (FOUO) JTU 4.1.1 will consist of three Rifle Companies, one Engineer Platoon, one Stinger Detachment, two AAAV Platoons, and one MV22.

(6) (FOUO) JTU 4.3.1 will consist of three Rifle Companies, one Engineer Platoon, one Stinger Detachment, one AAAV Platoon, and two MV22s.

(7) (FOUO) Continuous coverage by RECON (TARPS) will be maintained in general support of theater CINC. May be tasked with any immediate imagery requirements.//

GENTEXT/MISSION/

2. (FOUO) On order, JTF 4 ground forces will seize and defend Yingian Port of Plethora, to allow introduction of follow on forces in support of Yingian government troops. Sea-based forces will support amphibious assault with CAS, naval gunfire, and air defense assets.//

GENTEXT/EXECUTION/

3. (FOUO) CONCEPT OF OPERATIONS

A. GROUND. Each GCE will simultaneously land one AAAV-Mounted Platoon on respective beach. JTU 4.3.1 will simultaneously take commanding terrain with one MV22. Once BOTH beaches and commanding terrain are secure, the two AAAV-Mounted Platoons will proceed down the roads from their respective beaches, clearing minefields with Engineer Platoons, killing counterattack forces with Cobra Sections, and conducting MEDEVACS as necessary. Once the roads have been cleared, the AAAV-Mounted Platoons will take the port and airfield. JTU 4.1.1s AAAV-Mounted Platoon will be assisted in its attack of the airfield by a MV22. It is important that once the AAAV-Mounted Platoons land on the beach, the airfield and port be taken as quickly as possible, before the enemy has a chance to organize his defense and send reinforcements. We would like to conduct the final assaults on the airfield and port simultaneously, in order to present the

enemy commander with the most confusing, dilemma-filled environment possible. However, if one attack must occur before the other, the airfield has the priority.

B. MARITIME. Due to hydrographic limitations, the DDG's and the CV will have to be significantly separated during the operation, enough to preclude them from being under a Joint Air Defense umbrella provided by the CG. Thus, the CG will remain with the CV, but will position itself so that it can rapidly move from the CV to the DDG's if that becomes necessary. Additionally, the two DDG's are inshore, providing NSFS support, while the FFG's are the primary ASW platform for the CV. The FFG's performing ASW will, like the CG, position themselves so that they can quickly move to support the DDG's if that is necessary.

4. (FOUO) TASK ASSIGNMENT JTU 4.3.1. On order from JTF 4, land one AAAV-Mounted Platoon on Red Beach. Simultaneously seize commanding terrain to the north of Red Beach with one MV22. Once the beach and commanding terrain are secure, attack along the road from the beach to the port, clearing minefields with Engineer Platoon, killing counterattack forces with Cobras and conducting MEDEVACS as necessary. Once the roads have been cleared, attack the port with the AAAV-Mounted Platoon.

5. (FOUO) TASK ASSIGNMENT JTU 4.1.1. On order from JTF 4, land one AAAV-Mounted Platoon on Blue Beach. Once the beach is secure, attack along the road from beach to airfield with AAAV-Mounted Platoon, clearing minefields with Engineer Platoon, killing counterattack forces with Cobras, and conducting MEDEVACS as necessary.

6. (FOUO) TASK ASSIGNMENT JTG 4.2. Keep two elements of CAS on standby at all times: one to be used against Frog or Scuds, and the other to be used against Silkworms. CV will provide 3 sections of air defense aircraft, with one CAP station over the CV and the others over the DDG's. FFG's will provide ASW.

7. (FOUO) TASK ASSIGNMENT JTG 4.1 and JTG 4.3. On order from JTF 4, units will clear mines from the beaches. Units will launch Marines for assault on Red and Blue Beaches. DDG's will suppress artillery strong-points ashore when requested to do so. Units will provide all MEDEVAC support and all Cobra support.

8. (FOUO) COORDINATING INSTRUCTIONS.

A.. (FOUO) This order effective for planning upon receipt and execution on order.

B. (FOUO) Dirlauth for planning and operations with Info CJCS and CINCMED.

C. (FOUO) ROE will be per CINCMED OPLAN 1234.

D. (FOUO) If the airfield attack is held up for any reason, the port attack will be delayed to retain the synergism of concurrent attacks. If the port attack is held up, the airfield attack will go forward.

E. (FOUO) JTU 4.1.1's attack on the airfield has priority, because buildup of forces can be most quickly and effectively achieved through air transport.

F. (FOUO) Enemy patrol boats or other surface craft will be engaged by the DDG's.

G. (FOUO) If both the DDG and the CV are threatened by the enemy, the DDG has priority of support against submarine threats, fixed-wing air threats, and patrol boats.

H. (FOUO) If there is a threat of an air attack against the DDG, the DDG will be protected by the CG or a CAP.

I. (FOUO) The FFG performing ASW and the CG will remain with the CV unless required by the DDG to meet a specific threat. In absence of such a specific threat, CV is considered a more likely target for the enemy.

J. (FOUO) CV has priority against land based Silkworm sites and helicopters.

K. (FOUO) The fighters will man at least 2 CAP stations.

L. (FOUO) DDG's will be in position to provide NSFS support against artillery strong-points, and will man fire support stations (FSS) about 4 miles directly east of the port.

GENTEXT/ADMIN AND LOG/

9. (FOUO) Per CINCMED OPLAN 1234, as amended herein.//

GENTEXT/COMMAND AND SIGNAL/

10. (FOUO) USCINCMED is supported CINC.

11. (FOUO) CJTF 4 is on-the-scene Commander and will exercise OPCON of advance forces until HQ USCINCMED FWD is activated.

12. (FOUO) Command relationships as outlined in Annex J, CINCMED OPLAN 1234.

13. (FOUO) Communications guidance as outlines in Annex K, CINCMED OPLAN 1234 as amended herein.//

AKNLDG/Y//

DECL/OADR//

IMMEDIATE NTA

FROM: USCINCMED NAPLES IT
CJTF FOUR

TO: CJCS WASHINGTON DC
USCINCCENT MACDILL AFB FL
USCINCLANT NORFOLK VA
USCINCEUR VAIHINGEN GE
CINCFOR FT MCPHERSON GA
USCINCPAC HONOLULU HI
USCINCTRANS SCOTT AFB IL
USCINCSTRAT OFFUTT AFB NE
COMMARFORPAC HONOLULU HI
CINCPACFLT HONOLULU HI
JTF FOUR

INFO: WHITEHOUSE SITUATION ROOM WASHINGTON DC
SECSTATE WASHINGTON DC
SECDEF WASHINGTON DC
CSA WASHINGTON DC
CMC WASHINGTON DC
CNO WASHINGTON DC

DISTR: CINC/DCINC/CCJ1/CCJ2/CCJ3/CCJ4/CCJ5/CCJ6

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ORDTYP/OPORD/USCINCCENT 11-96//
MAP/1015/TUNSIA//
MAP/1020/YANG//
NARR/SCALE 1:100,000//
TIMEZONE/Z//

HEADING/TASK ORGANIZATION//

UNITS

/UNITDES	/UNITLOC	/CMNTS
/USCINCLANT	/NORFOLK VA	
/USCINCEUR	/VAIHINGEN GE	
/CINCFOR	/FT MCPHERSON GA	
/USCINCPAC	/HONOLULU HI	
/USCINCTRANS	/SCOTT AFB IL	/2 TAC ARLFT SQ
		/6 KC-10
/USCINCSTRAT	/OFFUTT AFB NE	/2 RC-135
/COMMARFORPAC	/HONOLULU HI	/1 MEB
/CINCPACFLT	/HONOLULU HI	
/HQ USMEDCOM FWD		/(JTF 4)
/HQ USMEDAF (MINUS)		
/HQ USNAVMED (MINUS)		
/SUPPORTING FORCES		
/COMSUPNAVFOR		
/MPS//		

GENTEXT/SITUATION

1. (FOUO) Yang has attacked the friendly nation of Ying. Attacking forces have succeeded in seizing Yingian port of Plethora. Yingian government has requested U.S. assistance in taking back port of Plethora and driving Yangian forces from Ying.

A. (FOUO) ENEMY FORCES

6. (FOUO) See current SITREP and DIN. Port of Plethora protected by obstructions, mines, obstacles, and the presence of hidden enemy among the port facility buildings. Two beaches approx. 5 miles south of the port may be suitable for amphibious assault. Northernmost beach (designated "Red Beach") has road leading to the port. Southernmost beach (designated "Blue Beach") has a road leading to the airfield. Waterborne approaches to the beaches are possibly mined. Commanding terrain to north of Red Beach believed occupied by enemy Heavy Mortar Platoon with a platoon of Infantry for security. This terrain dominates both Red Beach and the port. Seizure and retention of this dominant terrain should be considered essential for successful attack on Red Beach and port.

(2) (FOUO) Believed to be at port, but hidden from view, is company-sized armored counterattack force that could move toward Red Beach in response to any amphibious assault. Similar counterattack force may exist at airfield, which is located about 5 miles inland from the Blue Beach. These counterattack forces could inflict serious damage if not interdicted before they reach either beach. Off-road terrain between beach, port, airfield, and commanding terrain is swampy and treacherous; and is unsuitable for travel. Thus, all travel must be on the two roads. It is believed that one or both of the roads will be mined. Locations of any minefields are currently unknown. Port, airfield, both roads, both beaches, and commanding terrain are located within range of artillery strong-points. Northernmost strong-point can range Red Beach and port. Southernmost strong-point can range both Blue Beach and airfield. Artillery pieces are housed in reinforced concrete bunkers, with ammunition stored in deep underground bunkers. It is unlikely that even concentrated air attacks will completely disable the artillery strong-points. Enemy can be expected to wheel out artillery pieces (from 8 to 24 at a time), set up, sight in, and fire within 5 minutes. If friendly forces can get effective NSFS on target in less than 5 minutes, the enemy will most probably wheel their artillery pieces back into bunkers and wait until another time.

(3) (FOUO) Enemy also has several Frog Missile Launchers known to be capable of carrying chemical munitions. Frogs believed to be hidden in the vicinity of both artillery strong-points. They can emerge from covered positions, prepare warheads, and fire missiles within 10 minutes. Past experience has shown that Frog crews are more stalwart than artillery crews. They will continue to prepare and launch their missiles even if they are being suppressed by NSFS or artillery.

(4) (FOUO) Submarine threat is considerable. Enemy has at least one Alfa-Class submarine known to be in the area, and possibly more.

(5) (FOUO) Enemy possess HIND Helicopters, which have demonstrated the capability to launch anti-ship missiles. The DDG, CG and CV possess capabilities to counter these helicopters.

7. (FOUO) The enemy has significant air strike capability, and can launch anti-ship missiles from most of its strike aircraft.

(7) (FOUO) The enemy's Special Forces also possess numerous fast patrol boats, that can either fire very potent Russian torpedoes or be loaded with explosives for suicide missions.

(8) (FOUO) There are Silkworm threats throughout the area. The Silkworm missiles are placed in residential neighborhoods because they know U.S. will be reluctant to target residential areas. Accordingly, if U.S. warships want to target a Silkworm launcher, they must first get visual confirmation of its presence, using theater RECON (TARPS) assets, and any strike must use precision guided munitions.

B. (FOUO) FRIENDLY FORCES. JTF 4 will be comprised primarily of assets organic to Mediterranean Command (MEDCOM). A theater-level JFACC and other friendly forces are operating against the enemy in Ying, but not in concert with the JTF.

(1) (FOUO) JTF 4 will consist of one CV, one RECON (TARPS), eight CAS Sections and subordinate units (4.1, 4.2, 4.3, 4.2.1, 4.2.2).

8. (FOUO) JTU 4.1 will consist of three Rifle Companies, one LHA, one AAAV Platoon, two MV22s, and one Stinger Detachment.

(3) (FOUO) JTU 4.2 will consist of two Cobra Sections.

9. (FOUO) JTU 4.3 will consist of three Rifle Companies, one LPD, two AAAV Platoons, one MV22, one Stinger Detachment, and two Cobra Sections.

(5) (FOUO) JTG 4.2.1 will consist of two DDGs, one CG, one Engineer Platoon, one Huey MEDEVAC, and one MH-53 MCM.

(6) (FOUO) JTG 4.2.2 will consist of two FFGs, one Engineer Platoon, one Huey MEDEVAC, one MH-53 MCM, and eight Fighter Sections.

(7) (FOUO) Continuous coverage by RECON (TARPS) will be maintained in general support of theater CINC. May be tasked with any immediate imagery requirements.//

GENTEXT/MISSION/

2. (FOUO) On order, JTF 4 ground forces will seize and defend Yingian Port of Plethora, to allow introduction of follow on forces in support of Yingian government troops. Sea-based forces will support amphibious assault with CAS, naval gunfire, and air defense assets.//

GENTEXT/EXECUTION/

10. (FOUO) CONCEPT OF OPERATIONS

A. GROUND. Each GCE will simultaneously land one AAAV-Mounted Platoon on respective beach. JTU 4.1 will simultaneously take commanding terrain with one MV22. Once BOTH beaches and commanding terrain are secure, the two AAAV-Mounted Platoons will proceed down the roads from their respective beaches, clearing minefields with Engineer Platoons, killing counterattack forces with Cobra Sections, and conducting MEDEVACS as necessary. Once the roads have been cleared, the AAAV-Mounted Platoons will take the port and airfield. It is important that once the

AAAV-Mounted Platoons land on the beach, the airfield and port be taken as quickly as possible, before the enemy has a chance to organize his defense and send reinforcements. We would like to conduct the final assaults on the airfield and port simultaneously, in order to present the enemy commander with the most confusing, dilemma-filled environment possible. However, if one attack must occur before the other, the airfield has the priority.

B. MARITIME. Due to hydrographic limitations, the DDG and the CV will have to be significantly separated during the operation, enough to preclude them from being under a Joint Air Defense umbrella provided by the CG. Thus, the CG will remain with the CV, but will position itself so that it can rapidly move from the CV to the DDG if that becomes necessary. Additionally, the two DDG's are inshore, providing NSFS support, while the FFG is the primary ASW platform for the CV. The FFG performing ASW will, like the CG, position itself so that it can quickly move to support the DDG if that is necessary.

4. (FOUO) TASK ASSIGNMENT JTU 4.1. On order from JTF 4, land one AAAV-Mounted Platoon on Red Beach. Simultaneously seize commanding terrain to the north of Red Beach with one MV22. Once the beach and commanding terrain are secure, attack along the road from the beach to the port, clearing minefields with Engineer Platoon, killing counterattack forces with Cobras and conducting MEDEVACS as necessary. Once the roads have been cleared, attack the port with the AAAV-Mounted Platoon.

5. (FOUO) TASK ASSIGNMENT JTU 4.3. On order from JTF 4, land one AAAV-Mounted Platoon on Blue Beach. Once the beach is secure, attack along the road from beach to airfield with AAAV-Mounted Platoon, clearing minefields with Engineer Platoon, killing counterattack forces with Cobras, and conducting MEDEVACS as necessary. Once the roads have been cleared, conduct a coordinated attack on the airfield with MV22.

6. (FOUO) TASK ASSIGNMENT JTU 4. Keep two elements of CAS on standby at all times: one to be used against Frog or Scuds, and the other to be used against Silkworms. CV will provide 3 sections of air defense aircraft, with one CAP station over the CV and the others over the DDGs.

7. (FOUO) TASK ASSIGNMENT JTG 4.2, JTG 4.2.1 and JTG 4.2.2. On order from JTF 4, JTG 4.2 will coordinate JTG 4.2.1 and JTG 4.2.2 to clear mines from Red and Blue Beaches, and launch Marines for assault on Red and Blue Beaches. Additionally, JTG 4.2 will coordinate JTG 4.2.1 and JTG 4.2.2 to defend northern and southern sectors, provide NSFS for artillery strong-points, provide MEDEVAC support, provide Engineer support, provide ASW with the FFGs and provide fighter support. JTG 4.2 will provide Cobra support.

8. (FOUO) COORDINATING INSTRUCTIONS.

A. (FOUO) This order effective for planning upon receipt and execution on order.

B. (FOUO) Dirlauth for planning and operations with Info CJCS and CINCMED.

C. (FOUO) ROE will be per CINCMED OPLAN 1234.

D. (FOUO) If the airfield attack is held up for any reason, the port attack will be delayed to retain the synergism of concurrent attacks. If the port attack is held up, the airfield attack will go forward.

E.. (FOUO) Unit 4.3's attack on the airfield has priority, because buildup of forces can be most quickly and effectively achieved through air transport.

F. (FOUO) Enemy patrol boats or other surface craft will be engaged by the DDGs.

G. (FOUO) If both the DDG and the CV are threatened by the enemy, the DDG has priority of support against submarine threats, fixed-wing air threats, and patrol boats.

H. (FOUO) If there is a threat of an air attack against the DDG, the DDG will be protected by the CG or a CAP.

I. (FOUO) The FFG performing ASW and the CG will remain with the CV unless required by the DDG to meet a specific threat. In absence of such a specific threat, CV is considered a more likely target for the enemy.

J. (FOUO) CV has priority against land based Silkworm sites and helicopters.

K. (FOUO) The fighters will man at least 2 CAP stations.

L. (FOUO) DDG's will be in position to provide NSFS support against artillery strong-points, and will man fire support stations (FSS) about 4 miles directly east of the port. //

M. (FOUO) Stringers are the only Close Air Support weapon available to JTF 4.1.1 and JTF 4.3.1.//

GENTEXT/ADMIN AND LOG/

9. (FOUO) Per CINCMED OPLAN 1234, as amended herein.//

GENTEXT/COMMAND AND SIGNAL/

10. (FOUO) USCINCMED is supported CINC.

11. (FOUO) CJTF 4 is on-the-scene Commander and will exercise OPCON of advance forces until HQ USCINCMED FWD is activated.

12. (FOUO) Command relationships as outlined in Annex J, CINCMED OPLAN 1234.

13. (FOUO) Communications guidance as outlines in Annex K, CINCMED OPLAN 1234 as amended herein.//

AKNLDG/Y//

DECL/OADR//

IMMEDIATE F2

FROM: USCINCMED NAPLES IT
CJTF FOUR

TO: CJCS WASHINGTON DC
USCINCCENT MACDILL AFB FL
USCINCLANT NORFOLK VA
USCINCEUR VAIHINGEN GE
CINCFOR FT MCPHERSON GA
USCINCPAC HONOLULU HI
USCINCTRANS SCOTT AFB IL
USCINCSTRAT OFFUTT AFB NE
COMMARFORPAC HONOLULU HI
CINCPACFLT HONOLULU HI
JTF FOUR

INFO: WHITEHOUSE SITUATION ROOM WASHINGTON DC
SECSTATE WASHINGTON DC
SECDEF WASHINGTON DC
CSA WASHINGTON DC
CMC WASHINGTON DC
CNO WASHINGTON DC

DISTR: CINC/DCINC/CCJ1/CCJ2/CCJ3/CCJ4/CCJ5/CCJ6

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REF/B/ORDER/CJCS/041142Z NOV 96//
NARR/JT STRAT CAP PLN (FY 96), CJCS ALERT ORDER//
ORDTYP/OPORD/USCINCCENT 11-96//
MAP/1015/TUNSIA//
MAP/1020/YANG//
NARR/SCALE 1:100,000//
TIMEZONE/Z//
/ARG 55.2
/ 1 MEB

/MPS//

GENTEXT/SITUATION

1. (FOUO) Yang has attacked the friendly nation of Ying. Attacking forces have succeeded in seizing Yingian port of Plethora. Yingian government has requested U.S. assistance in taking back port of Plethora and driving Yangian forces from Ying.

A. (FOUO) ENEMY FORCES See OPORDER Thunder Spear.

B. (FOUO) FRIENDLY FORCES. See OPORDER Thunder Spear.

GENTEXT/MISSION/

2. (FOUO) On order, JTF 4 will conduct a NEO at Plethora.//

GENTEXT/EXECUTION/

3. (FOUO) CONCEPT OF OPERATIONS.

A. (FOUO) Conduct Noncombatant Evacuation Order to remove United States citizens located in and around the port of Plethora. IAW Operation Thunder Spear. Special Forces personnel will be provided for the execution of the NEO Operation. Current chain of command may be altered to carry out this mission.//

4. (FOUO) COORDINATING INSTRUCTIONS.

A. (FOUO) This order effective for planning upon receipt and execution on order.

GENTEXT/ADMIN AND LOG/

5. (FOUO) Per OPORDER Thunder Spear.//

GENTEXT/COMMAND AND SIGNAL/

6. (FOUO) USCINCMED is supported CINC.//

7. (FOUO) CJTF 4 is on-the-scene Commander and will exercise OPCON of advance forces until HQ USCINCMED FWD is activated.

8. (FOUO) Command relationships as outlined in Annex J, CINCMED OPLAN 1234.

9. (FOUO) Communications guidance as outlines in Annex K, CINCMED OPLAN 1234 as amended herein.//

AKNLDG/Y//

DECL/OADR//

IMMEDIATE F3

FROM: USCINCMED NAPLES IT
CJTF FOUR

TO: CJCS WASHINGTON DC
USCINCCENT MACDILL AFB FL
USCINCLANT NORFOLK VA
USCINCEUR VAIHINGEN GE
CINCFOR FT MCPHERSON GA
USCINCPAC HONOLULU HI
USCINCTRANS SCOTT AFB IL
USCINCSTRAT OFFUTT AFB NE
COMMARFORPAC HONOLULU HI
CINCPACFLT HONOLULU HI
JTF FOUR

INFO: WHITEHOUSE SITUATION ROOM WASHINGTON DC
SECSTATE WASHINGTON DC
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DISTR: CINC/DCINC/CCJ1/CCJ2/CCJ3/CCJ4/CCJ5/CCJ6

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MAP/1015/TUNSIA//
MAP/1020/YANG//
NARR/SCALE 1:100,000//
TIMEZONE/Z//
/ 1 MEB
/MPS//

GENTEXT/SITUATION

1. (FOUO) Yang has attacked the friendly nation of Ying. Attacking forces have succeeded in seizing Yingian port of Plethora. Yingian government has requested U.S. assistance in taking back port of Plethora and driving Yangian forces from Ying.

A. (FOUO) ENEMY FORCES See OPORDER Thunder Spear.

B. (FOUO) FRIENDLY FORCES. See OPORDER Thunder Spear.

GENTEXT/MISSION/

2. (FOUO) JTF 4 can reorganize the current chain of command and unit assets prior to execution of Operation Thunder Spear.//

GENTEXT/EXECUTION/

3. (FOUO) CONCEPT OF OPERATIONS.

A. (FOUO) JTF personnel will evaluate current command structure and unit assets. Changes can be made to the chain of command and/or the unit assets to create a "better" structure for the execution of Operation Thunder Spear.//

1. (FOUO) TASK ASSIGNMENT JTF 4. JTF 4 will provide the following assets to JTF 195

1 LPD	1 LHA	2 Rifle Co	2 Cobra Sections
1 Eng. Plt	1 MEDEVAC	1 MCM	1 Stinger Detachment
2 CAS	2 Fighters	1 DDG	1 FFG
1 AAAV	1 MV22		

5. (FOUO) COORDINATING INSTRUCTIONS.

A. (FOUO) This order effective for planning upon receipt and execution on order.

B. (FOUO) There are NO restrictions on how the units can be reconstructed.

GENTEXT/ADMIN AND LOG/

6. (FOUO) Per OPORDER Thunder Spear.//

GENTEXT/COMMAND AND SIGNAL/

7. (FOUO) USCINCMED is supported CINC.//

8. (FOUO) CJTF 4 is on-the-scene Commander and will exercise OPCON of advance forces until HQ USCINCMED FWD is activated.

9. (FOUO) Command relationships as outlined in Annex J, CINCMED OPLAN 1234.

10. (FOUO) Communications guidance as outlines in Annex K, CINCMED OPLAN 1234 as amended herein.//

AKNLDG/Y//

DECL/OADR//

TASK NAME	POSSIBLE RESOURCE COMB0	POSSIBLE RESOURCE COMB0	POSSIBLE RESOURCE COMB0	POSSIBLE RESOURCE COMB0
HILL	1 RIFLE CO 1 CAS	1 RIFLE CO 2 DDG	1 RIFLE CO 1DDG 1FFG	1 RIFLE CO 1 CG 1 FFG
RED BEACH	1 CAS	2 DDG	1DDG 1FFG	1 COBRA SEC
BLUE BEACH	1 RIFLE CO 1 CAS	1 RIFLE CO 2 DDG	1 RIFLE CO 1DDG 1FFG	1 RIFLE CO 1 COBRA SEC
ARTILLERY	1DDG	1 CAS	2 FFG	
FROG LAUNCH	1DDG	1 CAS	2 FFG	
SILKWORM	1 CAS			
MINE LAND	1 ENG PLT			
MINE SEA	1 MCM HELO			
STRIKE AIR	1 FIGHTER SEC	1 STNGR DETCH	1DDG	1 CG
TACAIR	1DDG	1 CG		
HELO	1 FIGHTER SEC	1 STNGR DETCH	1DDG	1 CG
TANKS	1 COBRA SEC	2 DDG	1DDG 1 CAS	1 CAS 1 RIFLE CO
PATROL BOAT	1 FFG	1 COBRA SEC	1 DDG	1 CG
PATROL BOAT	1 CAS			
SUB	1 FFG			
ASCM	1 FIGHTER SEC	1 DDG	1 CG	

TASK NAME	POSSIBLE RESOURCE COMB0	POSSIBLE RESOURCE COMB0	POSSIBLE RESOURCE COMB0	POSSIBLE RESOURCE COMB0
MEDIVAC	1MED HELO			
HOLD	1 RIFLE CO			
SILKWORM AIR	1 FIGHTER SEC	1 DDG	1 CG	
SEAPORT	2 RIFLE CO 2 RIFLE CO	2 RIFLE CO 1 CG	2 RIFLE CO 1 COBRA SEC	2 RIFLE CO 1 CAS
AIRPORT	2 RIFLE CO 2 RIFLE CO	2 RIFLE CO 1 CG	2 RIFLE CO 1 COBRA SEC	2 RIFLE CO 1 CAS

DDD Tutorial

The DDD Graphical User interface

The DDD graphical user interface displays a map on the left side of the screen which is a graphical representation of friendly and enemy platforms. Within the map, land is represented by squares which have a brown tint, and sea by squares which are white. The mouse commands listed in the next section will describe how friendly platforms on the map may be manipulated and how information on enemy platforms is obtained. The right half of the screen contains four buttons:

- **Start/Refresh:** The Start button is used only at the beginning of a scenario to start all of the stations playing. Once the scenario has begun, the button changes to Refresh. Left clicking on the Refresh button redraws the map eliminating any undesired traces which may appear.
- **Zoom In:** Allows the user to zoom in for a more detailed look at a particular section of the map. To zoom in, left click on the "Zoom In" button. Move the cursor over to map and left click at a point to the left or right of where the area of interest lies. While continuing to hold the left mouse button depressed, drag the cursor and a box will begin to appear showing the area which will be zoomed in on.
- **Zoom Out:** Left clicking on this button returns the map to the previous map size.
- **Cancel:** Left Clicking on the Cancel button allows the user to suspend an operation on an asset such as a move or an attack prior to completing the mission.

The right half of the screen also contains a time bar. When a friendly platform or sub-platform is selected to perform an action (i.e. launch aircraft, attack), a white arrow will appear next to this bar showing the amount of time to complete this mission. The platform cannot perform any other action until this action is completed. In addition, above the time bar are several other pieces of information. The color of the stick man figure in a box shows the color of the platforms on the map which your station controls. Next to this box is the name of the station you are playing (i.e. CJTF 4, CJTG 4.1, etc.) Below the box are two counters which display feedback on how well the entire team is doing on the scenario. The counter labeled mission starts at zero and increments as missions are accomplished. The counter labeled strength starts at 100 and decrements as your force strength is decreased.

The lower portion of the screen contains two window dialog boxes. Close attention must be given to the window on the left as this box

displays messages between the various players which may require some action to be taken by your station. The right window can best be described as a confirmation window. Summaries of messages or actions performed by your station will appear in this window along with some messages about the status of other friendly platforms. Also, the very bottom of the screen below these two windows displays warning and error prompts. A beep will occur along with a warning or error message following any action performed by your station which is not allowed (i.e. Attempting to attack the enemy when your unit is out of range).

Using the Mouse in DDD

A standard three button mouse is used when running a scenario at each workstation. When clicking on an platform in DDD each mouse button serves a different function depending on whether the platform is friend or foe, and if friend whether or not the platform is owned or not owned by you.

Left Mouse Button

The left mouse button clicked on an platform will just select it. The left mouse button is also used to carry out options from a Right Mouse Menu covered on the next page.

Middle Mouse Button

When the middle button is clicked on an platform, the window presented depends on whether the platform is a (1) friendly platform or sub-platform or (2) enemy platform. If the platform is an enemy platform , a window appears which provides known information about the attributes of the platform. If a friendly platform is selected, a screen appears which displays the attributes of that platform or sub-platform. A friendly platform will show the attributes, ownership, and the number of all sub-platforms located on the platform is also shown. (Platforms are the major friendly platforms in the scenarios. Sub-platforms are platforms such as aircraft, Stinger detachments, engineering platoons, helicopters, etc. which are carried by a platform. The ownership of any sub-platform may or may not be the same as the owner of the platform it is being carried on).

When a friendly platform is selected with the middle mouse button, the portion of the window where the sub-platforms are listed is used to launch or request launch of a sub-platform depending on where the sub-platform is located. There are three possible situations which can occur here:

1. <u>Sub-platform needed to be launched is on a platform owned by you</u>: In this case you can launch any sub-platform on your platform whether you own it or not. This is done by left clicking on the right arrow key in the line for the number of sub-platform(s) needed and then clicking OK.

2. <u>Sub-platform needed to be launched is owned by you, but is located on a platform which you do not own:</u>
   a) In this case middle click on the platform where your sub-platform is located.
   b) Left click on the arrow located in the line of the sub-platform needed until the desired number of sub-platforms to be launched is set
   c) Left click on OK. A message will then be sent to the owner of the platform where your sub-platform is located requesting that it be launched. It is the responsibility of the person where your sub-platform resides to launch it.

1. <u>Sub-platform needed is not owned by you and is located on a platform not owned by you:</u> In this case middle click on the platform where the sub-platform needed resides. Left click on the arrow on the line containing the sub-platform desired until the required number is set, and then left click on OK. A message will then be forwarded up your chain of command which must be acted upon by your immediate superior to obtain this sub-platform.

The lower portion of this screen also offers options for displaying information on range for both sensors and weapons of a friendly platform against enemy ground, air, or sea assets. The sensor option will display four range rings around the platform:

1) The outermost black ring represents the detection range.
2) The next inner black ring represents the range at which measurements on the enemy can be made.
3) The furthest inner black ring represents the visual detection range.
4) The inner yellow ring represents the range at which the platform is vulnerable.

The weapons option displays a single red ring around the platform which shows the effective range of its weapon. To display these range rings left click on either sensors, weapon, or both, and then left click what type of medium to display these for (air, ground, or sea). To turn the range rings off, middle click on the platform and left click on none.

Right Mouse Button

The right mouse button will cause a menu to pop up. The following sections describe the options presented depending on the platform selected with the right mouse button.

Friendly platform which you do not own: The menu that pops up will present the option of requesting the asset, forcing the transfer of the asset, or information on the asset. Explanations of these options follow:

- **Request (REQ):** The menu requires input for who the request is to, and the urgency of the request. All items must be selected. When the choices are completed, a message is sent to the person selected if they are directly in your chain of command or up your chain of command where your superior must take action on the request.

- **Information (INFO):** Same as middle clicking on the platform.

Friendly platform which you own: This menu will allow the choices of Move, Pursue, Attack, Return, Transfer, or Information. An explanation of these options follow:

- **Move:** Selecting move will cause a cross-hair type symbol to appear. Position this cross hair to the place the platform is desired to be moved and single click with the left mouse button. The platform will then move to this position. When it arrives there, it will stop until another command to move is given.

- **Pursue:** Selecting pursue will cause the cursor to change to a finger. Place the finger on the enemy platform desired to be pursued, left click, and your platform will then move to pursue it..

- **Attack:** When this option is selected a question mark will appear. Place the question mark on the platform. If in range to perform this action, a menu will then appear which shows the attributes of the platform selected to perform the attack and the attributes of the platform that the attack is to be performed on. The option is then given to carry out the mission or to cancel the assignment.

• **Coordinated Attack**: If the platform selected to attack the enemy does not have enough combat power to accomplish the mission, a coordinated attack may be performed. It should be noted that the following explanations of how to do a coordinated attack will work only if all of the platforms are within attack range.

• **Coordinated Attack using Two Platforms**: A coordinated attack using two platforms is accomplished by first selecting one of the two platforms to perform the coordinated attack with the left mouse button, and then right clicking on the second platform performing the attack. The menu will then pop up and

select the attack option. The cursor will then change to the question mark. Place it on the platform which is to be attacked and left click with the mouse.

• **Coordinated Attack using Three or More Platforms**: To perform a coordinated attack with three or more platforms, left click on the first platform performing the attack. Then, while holding the shift key down on the keyboard, left click on all but one of the remaining platforms performing the attack. Release the shift key and right click on the final platform. The menu will pop up and select attack. The cursor will change to a question mark. Place it on the platform to be attacked and left click.

A simultaneous attack by two or more players may be needed to bring sufficient combat power to bear. These should be coordinated using the voice net.

- **Return:** This option may only be used for sub-platforms. Selecting this option will cause the sub-platform to return to the platform it originated from. The sub-platform will not move towards its originating platform, but instead will change to a box with a "x" in it to simulate returning to its originating platform. The return option has been disabled on some sub-platforms in the scenario. If one of these sub-platforms is directed to return, an error message will appear.

- **Information (INFO):** Same as middle clicking on the platform.

  Enemy Platforms: The menu presented in this instance presents the options of Identify, Requesting Information, Transferring Information, Coordinating Action, Assigning, and Information. Explanations of these options follow:

- **Identify:** This option is normally used to identify enemy platforms or s for which the identity is unknown. This will be readily apparent in a scenario as the first letter shown with the icon will be followed by a question mark. The first letter designates which medium the unknown contact operates in. "A?" denotes an unknown air contact; "G?" denotes an unknown ground contact; "S?" denotes an unknown sea contact. Selecting the identify option will cause a menu to pop up which shows the known attributes of the platform as seen by each player in the scenario. If a friendly platform having sensors capable of identifying the enemy platform is within sensor range the platform will be identified correctly. If not, the question mark will remain. This will be apparent by looking at the lower left hand column where the identity will be shaded from a list of possible identities. Click the fused button near the top left hand corner and then OK. The identity of the platform will then appear correctly on the map and its icon will change to its correct identity.

The following tables give descriptions of the two letter symbols which will be the options shown when identifying an platform:

Unknown Ground	Description
?	Unknown
HL	Ground mission of taking a hill
AP	Airport ground mission
SP	Seaport ground mission
HD	Holding or occupying ground
TK	Taking a ground mission
AT	Enemy artillery
FG	Enemy Frog launcher
SWG	Enemy Silkworm missile launcher
TN	Enemy tanks, troops, or vehicles
NU	Neutral
MN	Land Mines

Unknown Air	Description
?	Unknown
AS	Enemy attack against ships
AG	Enemy attack against ground forces
HH	Enemy helo attack against ships
NU	Neutral
SWA	Silkworm missile in flight

Unknown Sea	Description
?	Unknown
MS	Sea mines
PB	Enemy patrol boats
SS	Enemy submarines
ML	Enemy anti-ship cruise missiles
NU	Neutral

- **Request Information (REQ INFO):** Selecting this option will cause a menu to pop up which allows you to select an other player, or all other players from whom you wish to obtain information on the enemy platform. Select the person(s) and click OK. A message will then be sent to the person(s) notifying them that this information is requested.

- **Transfer Information (XFR INFO):** Selecting this option will cause a menu to pop up which allows you to select a particular individual, or all the players you wish information on the enemy platform to be sent to . Select the person(s) and click OK. A message will then be sent to the person(s) selected.

- **Coordinate Action (CRD ACTION):** The use of this option allows messages to be sent between players concerning action requests, support, or intent against an enemy platform. When selected, a menu pops up displaying options for choosing who the message is to sent to and a list of messages which may be sent. The following messages may be sent:

    1. I plan to handle.
    2. I plan to support.
    3. I cannot handle.
    4. I cannot support.
    5. Can you handle ?
    6. Can you support ?

  Select the person the message is to be sent to, a message is to be sent, and click OK. The message will then be sent to the person selected.

- **Assign:** This option may only be used if you are playing a position where you are superior to someone in the chain of command and may only be

directed at those people who are subordinate to you. This option will cause a question mark to appear. Place it on the enemy platform desired to be assigned and left click. A menu will then appear which allows selecting whom in the chain of command it is to be assigned to. Left click on the person desired to assign the mission to and click OK. A message will then be sent to that person notifying them they are responsible for taking care of the mission.

- **Information (INFO):** Same as middle clicking on the platform.

List of Platforms in the Scenario

Terrain and task platforms

The following shows representations of the icons which represents terrain or task platforms in the scenarios.

Swamp: The swamp icon indicates areas which mechanized or infantry units <u>should not traverse</u>. Friendly units will not be destroyed by going into these areas, but total strength will be diminished.

Airfield: The airfield icon is the objective or mission to completed by CJTU 4.1.1. This airfield has attributes associated with it which must be compared to the attacking force attributes to determine if the necessary force is available.

PORT **Port:** The port is the objective or mission of CJTU 4.3.1. It, like the airfields, also has attributes which must first be determined and compared to attacking forces attributes to determine if enough combat power can be brought to bare to achieve this objective.

H **Hill:** The hill is commanding terrain between the port and airfield which must be captured by CJTU 4.3.1. It is surrounded by swamps on both sides which means the only way of accomplishing this mission is by using AAAV or MV-22 sub-platforms.

T **Task:** The task icon has attributes which must first be identified and then a determination made as to the best asset available to complete this task. Tasks are normally used to represent enemy ground forces in a given location which must be eliminated.

Medivac: The medivac icon is a mission which may appear after friendly ground platforms or sub-platforms engage enemy platforms . The

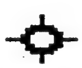
task has attributes which must be determined. The mission is completed by attacking it with the medivac helicopter (MED sub-platform).

HOLD **Hold:** The hold icon may appear after completion of a mission (i.e. attacking the hill). If this occurs the asset used to perform the mission must remain in its current position and may not be used to perform any other mission.

Enemy Assets

The following section shows the icons which represent enemy forces that may or may not appear in a scenario. The text which follows each icon describes the enemy platforms capabilities and the friendly weapon of choice to use against it.

 **Artillery:** Enemy artillery pieces may pop up at various times. When they appear, they take approximately 5 minutes to set up before they are able to fire. The pieces are stored in reinforced concrete bunkers with the ammunition stored in deep underground bunkers. The methods by which enemy artillery may be suppressed is through the use of Naval Surface Fire support (NSFS), Close Air Support (CAS), or Cobra attack helicopter. NSFS can be accomplished by either the DDG or CG. Once the artillery pieces begin to move toward you, which simulates firing, you will be unable to attack them.

 **Mines:** The enemy possesses the possibility of deploying both land and sea mines. If encountered and moved through by friendly forces the total effectiveness of these forces will be diminished. Sea based mines may only be cleared by the use of a mine clearing helicopter (MCM sub-platform) located on the ships. Land mines may only be cleared through the use of the engineering platoon (ENG sub-platform).

 **Frog Missile sites:** These sites are capable of launching short range missiles containing chemical munitions. The launchers take approximately 10 minutes to set up. Suppression must be done through the use of CAS aircraft carrying precision guided munitions located on the aircraft carrier, NSFS, or Cobra attack helicopter.

 **Silkworm Missile Site:** The enemy has placed silkworm missile sites in residential areas near the port. The appearance of a silkworm site requires visual confirmation through use of the Recon (Tarps sub-platform) prior to attacking the site. The site may only be destroyed by

using CAS carrying precision guided munitions, Cobra attack helicopters, or NSFS.

Submarines: The enemy submarines are Alpha class nuclear powered submarines. They can only be destroyed using the FFG platform.

Ship: The only ships the enemy possesses are fast patrol boats. These can be destroyed by using either the CG, DDG, or CAS aircraft.

Helicopter: The enemy possesses Hind helicopters capable of carrying Exocet anti-ship missiles. The friendly asset capable of destroying them are the CG, DDG, Stinger detachment (SD sub-platform), and fighters (VF sub-platform).

Aircraft: Enemy aircraft may launch attacks against the ships. Aircraft may be destroyed by using either the CG, DDG, Stinger detachment, or fighter aircraft located on the carrier.

Tanks: Enemy tanks may be encountered along the road during the assaults on both the airfield and the port. The tanks can only be seen when within the detection range of friendly ground forces. If friendly forces move out of range the tank icon will disappear. Tanks can only be destroyed by using the Cobra attack helicopters, CAS aircraft, or NSFS from either the DDG or CG.

? **Unknown Enemy Platform:** When this icon appears it must first be identified to determine what it is. The icon will have a letter designation followed by a "?". "A" denotes unknown air; "G" denotes unknown ground; and "S" denotes unknown sea. The platform must be identified with a suitable friendly platform or sub-platform. Identification of unknown ground platforms may only be accomplished using the Recon aircraft (Tarps sub-platform) located on the carrier.

Friendly Assets

Friendly Platform Icon: This icon is used to represent friendly platforms in a scenario. The middle of the box will contain a letter to show the type of medium in which the platform operates. The letter "G" denotes

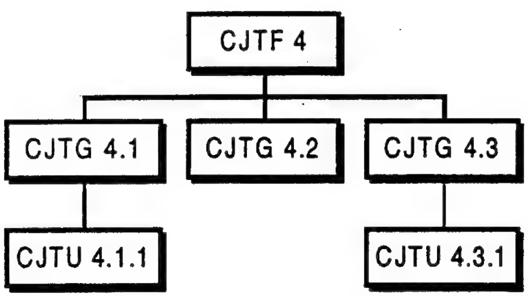
a ground asset; the letter "S' denotes a sea asset; and the letter "A" denotes an air asset. An additional letter and number designator will be shown on the map above the icon for further identification (i.e. CVN-01). Platform icons are color coded to show ownership.

Friendly Sub-platform Icon: When launched from its parent platform a sub-platform will appear as a circle with a letter and number combination above it for further identification (i.e. MCM-01). The middle of the circle will contain a letter to show the type of medium in which the platform operates. The letter "G" denotes a ground asset; the letter "S' denotes a sea asset; and the letter "A" denotes an air asset. Sub-platform icons are also color coded to show ownership.

Friendly Platform/Sub-platform Busy Icon: When a platform or sub-platform is directed to perform some mission such as attacking; transfer ownership between players; launch a sub-platform; or when a sub-platform is directed to return, the icon will change to a box with a "x" in it. The platform or sub-platform cannot be directed to perform any other function until this mission is completed. At the end of the mission it will change back to its previous form.

Chain of Command

The following organizational structure will be used in the scenarios.



CJTF 4: Overall commander of the operation as delineated in the oporder. CJTF 4 commands the Recon tarps sub-platform in the scenario. Units controlled by CJTF in a scenario will be black in color.

CJTG 4.1: Reports directly to CJTF 4 in the chain of command. Commands a LHA, a LPD, and a DDG. **ONLY THE LPD WILL BE SHOWN ON THE COMMON OPERATIONSL DISPLAY. ALL SUB-PLATFORMS WILL BE LAUNCHED FROM THE LPD DURING GAME**

PLAY. Also commands two AH-1 Cobra sub-platforms, one UH-1 Medivac, and one MH-53 MCM. Responsible for coordination of JTU 4.1.1 in attacking Blue Beach. Units controlled by CJTG 4.1 will be green in color.

CJTG 4.2: Reports directly to CJTF 4 in the chain of command. Commands one CG, the CV, two FFGs, eight fighter sections, and eight CAS sections. Units controlled by CJTG 4.2 will be blue in color.

CJTG 4.3: Reports directly to CJTF 4 in the chain of command. Commands a DDG, a LHA, and a LPD. **ONLY THE LHA WILL BE SHOWN ON THE COMMON OPERATIONAL DISPLAY. ALL SUB-PLATFORMS WILL BE LAUNCHED FROM THE LHA DURING GAME PLAY**. Also commands two AH-1 Cobra sub-platforms, one UH-1 MEDIVAC, and one MH-53 MCM. Responsible for coordination of JTU 4.3.1 in attacking Red Beach, commanding terrain, and taking the port. Units controlled by CJTG 4.3 are magenta in color.

CJTU 4.1.1: Reports directly to CJTG 4.1 in the chain of command. Commands three rifle companies, two AAAV mounted platoons, Engineering platoon for land mine clearing, a Stinger detachment, and one MV-22 Osprey flight. . One AAAV or one MV-22 carries one rifle company ashore. Responsible for assaulting Blue Beach and taking the airfield. Units controlled by CJTU 4.1.1 will be red in color.

CJTU 4.3.1: Reports directly to CJTG 4.3 in the chain of command. Commands three rifle companies, a AAAV mounted platoon, Engineering platoon, a Stinger detachment, and two MV-22 Osprey flights. One AAAV or one MV-22 carries one rifle company ashore. Responsible for assaulting Red Beach, the commanding terrain, and taking the port. Units controlled by CJTU 4.3.1 will be orange in color.

Platform	Owner	Sub-platform (QTY)	Capability	Description
LHA-01	CJTG 4.1	AH1, MED1, MCM1, MV1		Large Deck amphib to support Blue Beach assault
LPD-01	CJTG 4.1	CO1, ENG1, SD1, AAAV1		Troop carrier amphib to support Blue Beach assault
DDG-01	CJTG 4.1		NSFS AAW	Destroyer
CVN-02	CJTG 4.2	VF, Recon, CAS		Aircraft Carrier
CG-02	CJTG 4.2		NSFS AAW	Cruiser
FFG-002A	CJTG 4.2		ASW	Frigate
FFG-002B	CJTG 4.2		ASW	Frigate
LHA-03	CJTG 4.3	AH3, MED3, MCM3, MV3		Large Deck amphib to support Red Beach assault
LPD-03	CJTG 4.3	CO3, ENG3, SD3, AAAV3		Troop carrier amphib to support Red Beach assault
DDG-03	CJTG 4.3		NSFS AAW	Destroyer
Sub-Platform	**Owner**	**Location**	**Quantity**	**Capability**
Recon	CJTF 4	CVN-02	1	F-14 Tarps for Recon only
AH1	CJTG 4.1	LHA-01	2	Cobra Attack Helicopter
MED1	CJTG 4.1	LHA-01	1	UH-1 Medivac
MCM	CJTG 4.1	LHA-01	1	Helicopter for clearing sea based mines
VF	CJTG 4.2	CVN-02	8	F-14 fighers for CAP
CAS	CJTG 4.2	CVN-02	8	F/A-18 equiped with precision guided munitions
AH3	CJTG 4.3	LHA-03	2	Cobra Attack Helicopter
MED3	CJTG 4.3	LHA-03	1	UH-1 Medivac
MCM3	CJTG 4.3	LHA-03	1	Helicopter for clearing sea based mines
CO1	CJTU 4.1.1	LPD-01	3	Rifle Companies
AAAV1	CJTU 4.1.1	LPD-01	2	AAAV mounted platoon
ENG1	CJTU 4.1.1	LPD-01	1	Engineering platoon for clearing land mines
SD1	CJTU 4.1.1	LPD-01	1	Stinger Detachment for Anti-Air Defense
MV1	CJTU 4.1.1	LHA-01	1	MV-22 Osprey
CO3	CJTU 4.3.1	LPD-03	3	Rifle Companies
AAAV3	CJTU 4.3.1	LPD-03	1	AAAV mounted platoon
ENG3	CJTU 4.3.1	LPD-03	1	Engineering platoon for clearing land mines
SD3	CJTU 4.3.1	LPD-03	1	Stinger Detachment for Anti-Air Defense
MV3	CJTU 4.3.1	LHA-03	2	MV-22 Osprey

DDD Tutorial

The DDD Graphical User interface

The DDD graphical user interface displays a map on the left side of the screen which is a graphical representation of friendly and enemy platforms. Within the map, land is represented by squares which have a brown tint, and sea by squares which are white. The mouse commands listed in the next section will describe how friendly platforms on the map may be manipulated and how information on enemy platforms is obtained. The right half of the screen contains four buttons:

- **Start/Refresh:** The Start button is used only at the beginning of a scenario to start all of the stations playing. Once the scenario has begun, the button changes to Refresh. Left clicking on the Refresh button redraws the map eliminating any undesired traces which may appear.
- **Zoom In:** Allows the user to zoom in for a more detailed look at a particular section of the map. To zoom in, left click on the "Zoom In" button. Move the cursor over to map and left click at a point to the left or right of where the area of interest lies. While continuing to hold the left mouse button depressed, drag the cursor and a box will begin to appear showing the area which will be zoomed in on.
- **Zoom Out:** Left clicking on this button returns the map to the previous map size.
- **Cancel:** Left Clicking on the Cancel button allows the user to suspend an operation on an asset such as a move or an attack prior to completing the mission.

The right half of the screen also contains a time bar. When a friendly platform or sub-platform is selected to perform an action (i.e. launch aircraft, attack), a white arrow will appear next to this bar showing the amount of time to complete this mission. The platform cannot perform any other action until this action is completed. In addition, above the time bar are several other pieces of information. The color of the stick man figure in a box shows the color of the platforms on the map which your station controls. Next to this box is the name of the station you are playing (i.e. CJTF 4, CJTG 4.1, etc.) Below the box are two counters which display feedback on how well the entire team is doing on the scenario. The counter labeled mission starts at zero and increments as missions are accomplished. The counter labeled strength starts at 100 and decrements as your force strength is decreased.

The lower portion of the screen contains two window dialog boxes. Close attention must be given to the window on the left as this box

displays messages between the various players which may require some action to be taken by your station. The right window can best be described as a confirmation window. Summaries of messages or actions performed by your station will appear in this window along with some messages about the status of other friendly platforms. Also, the very bottom of the screen below these two windows displays warning and error prompts. A beep will occur along with a warning or error message following any action performed by your station which is not allowed (i.e. Attempting to attack the enemy when your unit is out of range).

Using the Mouse in DDD

A standard three button mouse is used when running a scenario at each workstation. When clicking on an platform in DDD each mouse button serves a different function depending on whether the platform is friend or foe, and if friend whether or not the platform is owned or not owned by you.

Left Mouse Button

The left mouse button clicked on an platform will just select it. The left mouse button is also used to carry out options from a Right Mouse Menu covered on the next page.

Middle Mouse Button

When the middle button is clicked on an platform, the window presented depends on whether the platform is a (1) friendly platform or sub-platform or (2) enemy platform. If the platform is an enemy platform , a window appears which provides known information about the attributes of the platform. If a friendly platform is selected, a screen appears which displays the attributes of that platform or sub-platform. A friendly platform will show the attributes, ownership, and the number of all sub-platforms located on the platform is also shown. (Platforms are the major friendly platforms in the scenarios. Sub-platforms are platforms such as aircraft, Stinger detachments, engineering platoons, helicopters, etc. which are carried by a platform. The ownership of any sub-platform may or may not be the same as the owner of the platform it is being carried on).

When a friendly platform is selected with the middle mouse button, the portion of the window where the sub-platforms are listed is used to launch or request launch of a sub-platform depending on where the sub-platform is located. There are three possible situations which can occur here:

1. <u>Sub-platform needed to be launched is on a platform owned by you</u>: In this case you can launch any sub-platform on your platform whether you own it or not. This is done by left clicking on the right arrow key in the line for the number of sub-platform(s) needed and then clicking OK.

2. <u>Sub-platform needed to be launched is owned by you, but is located on a platform which you do not own:</u>
   a) In this case middle click on the platform where your sub-platform is located.
   b) Left click on the arrow located in the line of the sub-platform needed until the desired number of sub-platforms to be launched is set
   c) Left click on OK. A message will then be sent to the owner of the platform where your sub-platform is located requesting that it be launched. It is the responsibility of the person where your sub-platform resides to launch it.

1. <u>Sub-platform needed is not owned by you and is located on a platform not owned by you:</u> In this case middle click on the platform where the sub-platform needed resides. Left click on the arrow on the line containing the sub-platform desired until the required number is set, and then left click on OK. A message will then be forwarded up your chain of command which must be acted upon by your immediate superior to obtain this sub-platform.

The lower portion of this screen also offers options for displaying information on range for both sensors and weapons of a friendly platform against enemy ground, air, or sea assets. The sensor option will display four range rings around the platform:

1) The outermost black ring represents the detection range.
2) The next inner black ring represents the range at which measurements on the enemy can be made.
3) The furthest inner black ring represents the visual detection range.
4) The inner yellow ring represents the range at which the platform is vulnerable.

The weapons option displays a single red ring around the platform which shows the effective range of its weapon. To display these range rings left click on either sensors, weapon, or both, and then left click what type of medium to display these for (air, ground, or sea). To turn the range rings off, middle click on the platform and left click on none.

Right Mouse Button

The right mouse button will cause a menu to pop up. The following sections describe the options presented depending on the platform selected with the right mouse button.

Friendly platform which you do not own: The menu that pops up will present the option of requesting the asset, forcing the transfer of the asset, or information on the asset. Explanations of these options follow:

- **Request (REQ):** The menu requires input for who the request is to, and the urgency of the request. All items must be selected. When the choices are completed, a message is sent to the person selected if they are directly in your chain of command or up your chain of command where your superior must take action on the request.

- **Information (INFO):** Same as middle clicking on the platform.

Friendly platform which you own: This menu will allow the choices of Move, Pursue, Attack, Return, Transfer, or Information. An explanation of these options follow:

- **Move:** Selecting move will cause a cross-hair type symbol to appear. Position this cross hair to the place the platform is desired to be moved and single click with the left mouse button. The platform will then move to this position. When it arrives there, it will stop until another command to move is given.

- **Pursue:** Selecting pursue will cause the cursor to change to a finger. Place the finger on the enemy platform desired to be pursued, left click, and your platform will then move to pursue it.

- **Attack:** When this option is selected a question mark will appear. Place the question mark on the platform. If in range to perform this action, a menu will then appear which shows the attributes of the platform selected to perform the attack and the attributes of the platform that the attack is to be performed on. The option is then given to carry out the mission or to cancel the assignment.

• **Coordinated Attack**: If the platform selected to attack the enemy does not have enough combat power to accomplish the mission, a coordinated attack may be performed. It should be noted that the following explanations of how to do a coordinated attack will work only if all of the platforms are within attack range.

• **Coordinated Attack using Two Platforms**: A coordinated attack using two platforms is accomplished by first selecting one of the two platforms to perform the coordinated attack with the left mouse button, and then right clicking on the second platform performing the attack. The menu will then pop up and

select the attack option. The cursor will then change to the question mark. Place it on the platform which is to be attacked and left click with the mouse.

• **Coordinated Attack using Three or More Platforms:** To perform a coordinated attack with three or more platforms, left click on the first platform performing the attack. Then, while holding the shift key down on the keyboard, left click on all but one of the remaining platforms performing the attack. Release the shift key and right click on the final platform. The menu will pop up and select attack. The cursor will change to a question mark. Place it on the platform to be attacked and left click.

A simultaneous attack by two or more players may be needed to bring sufficient combat power to bear. These should be coordinated using the voice net.

- **Return:** This option may only be used for sub-platforms. Selecting this option will cause the sub-platform to return to the platform it originated from. The sub-platform will not move towards its originating platform, but instead will change to a box with a "x" in it to simulate returning to its originating platform. The return option has been disabled on some sub-platforms in the scenario. If one of these sub-platforms is directed to return, an error message will appear.

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- **Identify:** This option is normally used to identify enemy platforms or s for which the identity is unknown. This will be readily apparent in a scenario as the first letter shown with the icon will be followed by a question mark. The first letter designates which medium the unknown contact operates in. "A?" denotes an unknown air contact; "G?" denotes an unknown ground contact; "S?" denotes an unknown sea contact. Selecting the identify option will cause a menu to pop up which shows the known attributes of the platform as seen by each player in the scenario. If a friendly platform having sensors capable of identifying the enemy platform is within sensor range the platform will be identified correctly. If not, the question mark will remain. This will be apparent by looking at the lower left hand column where the identity will be shaded from a list of possible identities. Click the fused button near the top left hand corner and then OK. The identity of the platform will then appear correctly on the map and its icon will change to its correct identity.

The following tables give descriptions of the two letter symbols which will be the options shown when identifying an platform:

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AG	Enemy attack against ground forces
HH	Enemy helo attack against ships
NU	Neutral
SWA	Silkworm missile in flight

Unknown Sea	Description
?	Unknown
MS	Sea mines
PB	Enemy patrol boats
SS	Enemy submarines
ML	Enemy anti-ship cruise missiles
NU	Neutral

- **Request Information (REQ INFO):** Selecting this option will cause a menu to pop up which allows you to select an other player, or all other players from whom you wish to obtain information on the enemy platform. Select the person(s) and click OK. A message will then be sent to the person(s) notifying them that this information is requested.

- **Transfer Information (XFR INFO):** Selecting this option will cause a menu to pop up which allows you to select a particular individual, or all the players you wish information on the enemy platform to be sent to . Select the person(s) and click OK. A message will then be sent to the person(s) selected.

- **Coordinate Action (CRD ACTION):** The use of this option allows messages to be sent between players concerning action requests, support, or intent against an enemy platform. When selected, a menu pops up displaying options for choosing who the message is to sent to and a list of messages which may be sent. The following messages may be sent:

  1. I plan to handle.
  2. I plan to support.
  3. I cannot handle.
  4. I cannot support.
  5. Can you handle ?
  6. Can you support ?

  Select the person the message is to be sent to, a message is to be sent, and click OK. The message will then be sent to the person selected.

- **Assign:** This option may only be used if you are playing a position where you are superior to someone in the chain of command and may only be

directed at those people who are subordinate to you. This option will cause a question mark to appear. Place it on the enemy platform desired to be assigned and left click. A menu will then appear which allows selecting whom in the chain of command it is to be assigned to. Left click on the person desired to assign the mission to and click OK. A message will then be sent to that person notifying them they are responsible for taking care of the mission.

- **Information (INFO):** Same as middle clicking on the platform.

List of Platforms in the Scenario

Terrain and task platforms

The following shows representations of the icons which represents terrain or task platforms in the scenarios.

 **Swamp:** The swamp icon indicates areas which mechanized or infantry units <u>should not traverse</u>. Friendly units will not be destroyed by going into these areas, but total strength will be diminished.

 **Airfield:** The airfield icon is the objective or mission to completed by CJTG 4.3. This airfield has attributes associated with it which must be compared to the attacking force attributes to determine if the necessary force is available.

Port: The port is the objective or mission of CJTG 4.1. It, like the airfields, also has attributes which must first be determined and compared to attacking forces attributes to determine if enough combat power can be brought to bare to achieve this objective.

Hill: The hill is commanding terrain between the port and airfield which must be captured by CJTU 4.1. It is surrounded by swamps on both sides which means the only way of accomplishing this mission is by using the AAAV or MV-22 sub-platforms.

 **Task:** The task icon has attributes which must first be identified and then a determination made as to the best asset available to complete this task. Tasks are normally used to represent enemy ground forces in a given location which must be eliminated.

 **Medivac:** The medivac icon is a mission which may appear after friendly ground platforms or sub-platforms engage enemy platforms . The

task has attributes which must be determined. The mission is completed by attacking it with the medivac helicopter (MED sub-platform).

Hold: The hold icon may appear after completion of a mission (i.e. attacking the hill). If this occurs the asset used to perform the mission must remain in its current position and may not be used to perform any other mission.

Enemy Assets

The following section shows the icons which represent enemy forces that may or may not appear in a scenario. The text which follows each icon describes the enemy platforms capabilities and the friendly weapon of choice to use against it.

Artillery: Enemy artillery pieces may pop up at various times. When they appear, they take approximately 5 minutes to set up before they are able to fire. The pieces are stored in reinforced concrete bunkers with the ammunition stored in deep underground bunkers. The methods by which enemy artillery may be suppressed is through the use of Naval Surface Fire support (NSFS), Close Air Support (CAS), or Cobra attack helicopter. NSFS can be accomplished by either the DDG or CG. Once the artillery pieces begin to move toward you, which simulates firing, you will be unable to attack them.

Mines: The enemy possesses the possibility of deploying both land and sea mines. If encountered and moved through by friendly forces the total effectiveness of these forces will be diminished. Sea based mines may only be cleared by the use of a mine clearing helicopter (MCM sub-platform) located on the ships. Land mines may only be cleared through the use of the engineering platoon (ENG sub-platform).

Frog Missile sites: These sites are capable of launching short range missiles containing chemical munitions. The launchers take approximately 10 minutes to set up. Suppression must be done through the use of CAS aircraft carrying precision guided munitions located on the aircraft carrier, NSFS, or Cobra attack helicopter.

Silkworm Missile Site: The enemy has placed silkworm missile sites in residential areas near the port. The appearance of a silkworm site requires visual confirmation through use of the Recon (Tarps sub-platform) prior to attacking the site. The site may only be destroyed by

using CAS carrying precision guided munitions, Cobra attack helicopters, or NSFS.

Submarines: The enemy submarines are Alpha class nuclear powered submarines. They can only be destroyed using the FFG platform.

Ship: The only ships the enemy possesses are fast patrol boats. These can be destroyed by using either the CG, DDG, or CAS aircraft.

Helicopter: The enemy possesses Hind helicopters capable of carrying Exocet anti-ship missiles. The friendly asset capable of destroying them are the CG, DDG, Stinger detachment (SD sub-platform), and fighters (VF sub-platform).

Aircraft: Enemy aircraft may launch attacks against the ships. Aircraft may be destroyed by using either the CG, DDG, Stinger detachment, or fighter aircraft located on the carrier.

Tanks: Enemy tanks may be encountered along the road during the assaults on both the airfield and the port. The tanks can only be seen when within the detection range of friendly ground forces. If friendly forces move out of range the tank icon will disappear. Tanks can only be destroyed by using the Cobra attack helicopters, CAS aircraft, or NSFS from either the DDG or CG.

? **Unknown Enemy Platform:** When this icon appears it must first be identified to determine what it is. The icon will have a letter designation followed by a "?". "A" denotes unknown air; "G" denotes unknown ground; and "S" denotes unknown sea. The platform must be identified with a suitable friendly platform or sub-platform. Identification of unknown ground platforms may only be accomplished using the Recon aircraft (Tarps sub-platform) located on the carrier.

Friendly Assets

Friendly Platform Icon: This icon is used to represent friendly platforms in a scenario. The middle of the box will contain a letter to show the type of medium in which the platform operates. The letter "G" denotes

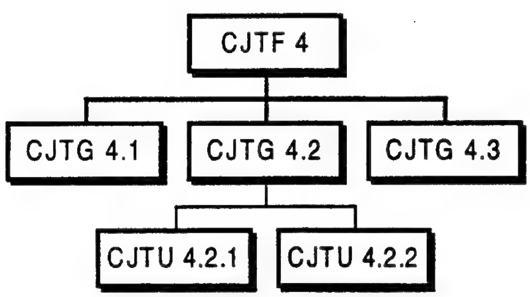
a ground asset; the letter "S' denotes a sea asset; and the letter "A" denotes an air asset. An additional letter and number designator will be shown on the map above the icon for further identification (i.e. CVN-01). Platform icons are color coded to show ownership.

Friendly Sub-platform Icon: When launched from its parent platform a sub-platform will appear as a circle with a letter and number combination above it for further identification (i.e. MCM-01). The middle of the circle will contain a letter to show the type of medium in which the platform operates. The letter "G" denotes a ground asset; the letter "S' denotes a sea asset; and the letter "A" denotes an air asset. Sub-platform icons are also color coded to show ownership.

Friendly Platform/Sub-platform Busy Icon: When a platform or sub-platform is directed to perform some mission such as attacking; transfer ownership between players; launch a sub-platform; or when a sub-platform is directed to return, the icon will change to a box with a "x" in it. The platform or sub-platform cannot be directed to perform any other function until this mission is completed. At the end of the mission it will change back to its previous form.

Chain of Command

The following organizational structure will be used in the scenarios.



CJTF 4: Overall commander of the operation as delineated in the oporder. CJTF 4 commands the aircraft carrier, CAS aircraft, and Recon tarps sub-platform in the scenario. Units controlled by CJTF in a scenario will be black in color.

CJTG 4.1: Reports directly to CJTF 4 in the chain of command. Commands three rifle companies, a LHA, and a LPD. **ONLY THE LPD WILL BE SHOWN ON THE COMMON OPERATIONSL DISPLAY. ALL SUB-PLATFORMS WILL BE LAUNCHED FROM THE LPD DURING GAME PLAY**. Also commands a AAAV mounted platoon, two MV-22 flights, and a Stinger Detachment. One AAAV or one MV-22 carries one rifle company ashore. Responsible for attacking Red Beach, commanding terrain, and taking the Port. Units controlled by CJTG 4.1 will be green in color.

CJTG 4.2: Reports directly to CJTF 4 in the chain of command. Responsible for the detachment of two AH-1 Cobras. CJTG 4.2 will coordinate the actions of CJTU 4.2.1 and CJTU 4.2.2. Units controlled by CJTG 4.2 will be blue in color.

CJTG 4.3: Reports directly to CJTF 4 in the chain of command. Commands three rifle companies, a LHA, and a LPD. **ONLY THE LHA WILL BE SHOWN ON THE COMMON OPERATIONAL DISPLAY. ALL SUB-PLATFORMS WILL BE LAUNCHED FROM THE LHA DURING GAME PLAY**. Also commands two AAAV mounted platoons, a MV-22 flight, a Stinger detachment, and two AH-1 Cobra attack helicopters. . One AAAV or one MV-22 carries one rifle company ashore. Responsible for attacking Blue Beach and taking the airfield. Units controlled by CJTG 4.3 are magenta in color.

CJTU 4.2.1: Reports directly to CJTG 4.2 in the chain of command. Commands two DDGs and the CG. Additionally commands an Engineering platoon, a MH-53 MCM, and a UH-1 MEDIVAC. Responsible for assisting CJTG 4.1 and CJTG 4.3 in the assault. Units controlled by CJTU 4.1.1 will be red in color.

CJTU 4.3.1: Reports directly to CJTG 4.2 in the chain of command. Commands two FFGs and 8 sections of fighters for CAP. Additionally commands an Engineering platoon, a MH-53 MCM, and a UH-1 MEDICAC. Responsible for ASW and supporting CJTG 4.1 and CJTG 4.3 in the assault. Units controlled by CJTU 4.3.1 will be orange in color.

Platform	Owner	Sub-platform (QTY)	Capability	Description
CVN-01	CJTF4	Recon, VF, CAS		Aircraft Carrier
LHA-01	CJTG 4.1	AH1, MED1, MCM1, MV1		Large Deck amphib to support Red Beach assault
LPD-01	CJTG 4.1	CO1, ENG1, SD1, AAAV1		Troop carrier amphib to support Red Beach assault
LHA-03	CJTG 4.3	AH3, MED3, MCM3, MV3		Large Deck amphib to support Blue Beach assault
LPD-03	CJTG 4.3	CO3, ENG3, SD3, AAAV3		Troop carrier amphib to support Blue Beach assault
DDG-01A	CJTU 4.2.1		NSFS AAW	Destroyer
DDG-01B	CJTU 4.2.1		NSFS AAW	Destroyer
CG-01	CJTU 4.2.1		NSFS AAW	Cruiser
FFG-02A	CJTU 4.2.2		ASW	Frigate
FFG-02B	CJTU 4.2.2		ASW	Frigate
Sub-Platform	**Owner**	**Location**	**Quantity**	**Capability**
Recon	CJTF 4	CVN-01	1	F-14 Tarps for Recon only
CAS	CJTF 4	LHA-01	8	F/A-18 equiped with precision guided munitions
CO1	CJTG 4.1	LPD-01	3	Rifle Companies
AAAV1	CJTG 4.1	LPD-01	1	AAAV mounted platoon
MV1	CJTG 4.1	LHA-01	2	MV-22 Osprey
SD1	CJTG 4.2	LPD-01	1	Stinger Detachment for Anti-Air Defense
AH1	CJTG 4.2	LHA-01	2	Cobra Attack Helicopter
CO3	CJTG 4.3	LPD-03	3	Rifle Companies
AAAV3	CJTG 4.3	LPD-03	2	AAAV mounted platoon
MV3	CJTG 4.3	LHA-03	1	MV-22 Osprey
SD3	CJTG 4.3	LPD-01	1	Stinger Detachment for Anti-Air Defense
AH3	CJTG 4.3	LHA-03	2	Cobra Attack Helicopter
ENG1	CJTU 4.2.1	LPD-01	1	Engineering platoon for clearing land mines
MCM1	CJTU 4.2.1	LHA-01	1	Helicopter for clearing sea based mines
MED1	CJTU 4.2.1	LHA-01	1	UH-1 MEDIVAC
VF	CJTU 4.2.2	CVN-01	8	F-14 fighters for CAP
ENG3	CJTU 4.2.2	LPD-03	1	Engineering platoon for clearing land mines
MCM3	CJTU 4.2.2	LHA-03	1	Helicopter for clearing sea based mines
MED3	CJTU 4.2.2	LHA-03	1	UH-1 MEDIVAC

APPENDIX B. DATA COLLECTION FORMS AND QUESTIONAIRES

Appendix B contains the forms used during the DDD-III runs and the planning sessions to record observations and the results of the players planning sessions and the questionaires the players were asked complete at the end of the trials.

A2C2 EXPERIMENT POST-PLANNING QUESTIONAIRE

Name:____________________________ Position:__________ ________

Team ID:________ Planning Session:_______ Date:_____________

This questionaire is comprised of three parts. The first part asks you to speculate about changes that would be required in the organization and architecture you designed if different priorities were in effect. The second part asks you to rate several attributes of high priority tasks. The third part inquires about aspects of the planning and designing products.

PART I: Different Priorities

1. If you were instructed to plan and design your organization and architecture to cope with a very short time period and minimize the amount of time necessary to accomplish the revised mission after the event, what changes would you make to the organization and architecture you devise? Describe these changes (if any) briefly.

2. What if you were asked to minimize the amount of assets and resources needed to complete the mission, what changes would you make to the organization and architecture you devise? Describe these changes (if any) briefly.

3. What if you were asked to minimize the amount of risk involved in the operation, what changes would you make to the organization and architecture you devise? Describe these changes (if any) briefly.

PART 2: Attributes of High Priority Tasks

examine the plan you have just completed and select the **three** (3) highest priority (i.e. most critical) tasks that must be completed to accomplish the mission. Write a descriptive name for the highest priority task under Task 1, the next highest priority task under Task 2, etc. Some tasks require a short amount of time to complete, but their execution is critical to the mission. Other tasks are important because they demand a great deal of time to complete. Still other tasks are not critical unless they are not done, then they become very critical because terrible things can happen. Consider the different reasons the tasks you selected are critical and rate each of these tasks on the scales below.

Task 1 ______	Task 2 ______	Task 3 ______
Time spent - The amount of time spent, relative to other tasks in the mission.		
I I I I I I a little a lot	I I I I I I a little a lot	I I I I I I a little a lot
Task difficulty - How difficult it is to perform the task, relative to all other tasks in the mission.		
I I I I I I a little a lot	I I I I I I a little a lot	I I I I I I a little a lot
Task criticality - Degree to which incorrect performance of the task would result in negative consequences.		
I I I I I I a little a lot	I I I I I I a little a lot	I I I I I I a little a lot
Task responsibility - Degree of direct, constant personnel responsibility for completing the task.		
I I I I I I a little a lot	I I I I I I a little a lot	I I I I I I a little a lot
Difficulty to learn task - The amount of time and effort that is required to learn to mange the task, relative to all other tasks in the mission.		
I I I I I I a little a lot	I I I I I I a little a lot	I I I I I I a little a lot
Overall importance - The overall importance of the task, relative to all other tasks in the mission.		
I I I I I I a little a lot	I I I I I I a little a lot	I I I I I I a little a lot

PART 3: Rationale

1. Consider the original organization and architecture you used when performing on the DDD-III simulation and compare it to the organization and architecture you have devised to address the event. Rate the degree of change or adaption of the new organization and architecture to cope with the event.

I 1 I 2 I 3 I 4 I 5 I 6 I 7 I

very little ... a great deal

2. How confident are you that the organization and architecture you have devised will accomplish the revised mission caused by the event?

I 1 I 2 I 3 I 4 I 5 I 6 I 7 I

very little ... a great deal

3. How adequate was the amount of resources available to deal with the event and the remainder of the original mission?

I 1 I 2 I 3 I 4 I 5 I 6 I 7 I

not adequate ... very adequate

4. How deficient was the original organization and architecture **PRIOR** to the event?

I 1 I 2 I 3 I 4 I 5 I 6 I 7 I

very little ... a great deal

5. How deficient was the original organization and architecture **AFTER** the event?

I 1 I 2 I 3 I 4 I 5 I 6 I 7 I

very little ... a great deal

ADAPTIVE ARCHITECTURES FOR COMMAND AND CONTROL (A2C2) POST-PLANNING ASSESSMENT: OBSERVER RATING FORM

Team ID:__________ Date:___________ Observer:_______________

Instructions for Post-Planning Assessment

Please assess the post-planning behavior of the team for the following activities using the scales provided. Base the rating on what you heard and observed not on what you guess and think.

1. To what extent did the team strive to understand the new situation/mission created by the trigger event?

Very Little 1 2 3 4 5 6 7 A Great Deal

Comments: ____

2. How well did the team appear to understand the new/situation/mission created by the trigger event?

Not Well 1 2 3 4 5 6 7 Very Well

Comments: ____

3. How organized and focused did the team appear to be while working the planning task?

Unfocused And Chaotic 1 2 3 4 5 6 7 Very focused And Organized

Comments: ____

4. To what extent did the team address workload disparities among the organizational nodes?

Very Little 1 2 3 4 5 6 7 A Great Deal

Comments: ____

5. To what extent did the team strive to produce an architecture (organizational structure) that distributed and equalized the workload among the organizational nodes?

Very Little	1	2	3	4	5	6	7	A Great Deal

Comments: ____

6. Did the team strive to produce a more traditional or more untraditional architecture (organizational structure) from the one they initially experienced?

More Traditional	1	2	3	4	5	6	7	More Nontraditional

Comments: ____

A2C2 EXPERIMENT
PLANNING ORGANIZER AND PRODUCTS BOOKLET

Team ID:________ Planning Session:________ Date:______

Record the names of the four team members and the positions they played below:

1.____________________ 3. ____________________

2. ____________________ 4. ____________________

WHEN DOING YOUR PLANNING: BE FOCUSED — BE BOLD --- BE DECISIVE

You are free to: alter the authority structure (who reports to whom), alter the communications structure (who can speak to whom), reorganize the resources (assets) among the nodes (i.e. positions), and change the tasks a node or position is to perform. In shortchange the architecture (organizational structure). **However, the number of nodes or positions is fixed at six (6) and the amount of resources are fixed.**

The purpose of the forms in this booklet is two-fold:

- To help you replan the mission given the event and modify the existing organization and architecture, if you so desire.
- To record the different planning products for analysis.

As a team you are asked to:

- Provide a brief situation assessment.
- Write a brief mission statement.
- Provide diagrams of the authority and communication structure (architecture).
- List the new tasks created by the event (if any) and tasks from the original mission that must be altered or reassigned. You are also asked to map resources against the tasks, state who will perform the tasks, sequence the tasks and estimate how long it will take to perform each task.
- Provide a synchronization and coordination chart indicating the synchronization among the tasks.

We strongly request that you perform each of the tasks listed above as you go through the planning and designing process and not wait until the end of the session. The tasks are designed to give structure to the planning and designing process and to help you organize your efforts. We also recommend that you do the tasks roughly in the order they are listed, but we understand that there might be some iterations back and forth between tasks.

SITUATION ASSESSMENT

Carefully consider the event and the initial mission. What has happened? What do you know? Prepare a situation assessment brief in **50 or fewer** words and write itin the space provided below.

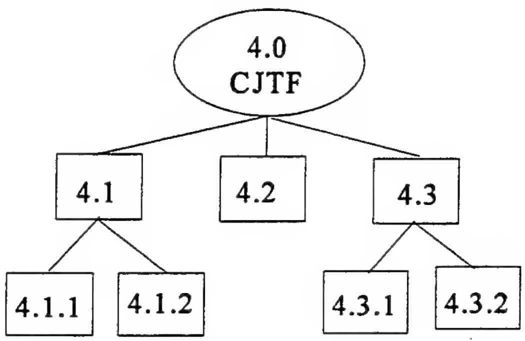
MISSION STATEMENT

After you and your team have come to an understanding of the tactical situation, prepare a mission statement of **100 or fewer** words that would be suitable to brief a commanding officer.

ARCHITECTURE: AUTHORITY

Please construct what you would consider the most appropriate command architecture for dealing with the event. This should be done in the form of a wire diagram as shown in the example below.

Example Architecture



Your Architecture Chart Below

ARCHITECTURE: COMMUNICATION

Redraw your command architecture in the space below. On this diagram, include the communications links that each node is allowed to use. For example, draw lines from each to the other nodes with whom they can communicate.

- Indicate (by using double lines) which communications links are most crucial.

- Who will be talking to whom the most?

TASK GRAPH

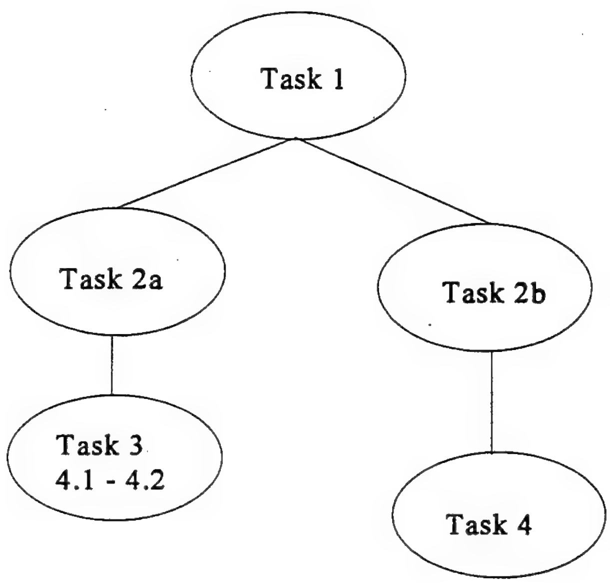
The following form provides a framework that you can use to organize information about the tasks your team must perform in this trial. That is, any new tasks created by the event, plus any tasks from the original mission that must be altered or reassigned. Please list the tasks you need to perform, which team position or positions are responsible (using the same position designations used in the authority diagram) for performing each task, and the resources necessary to accomplish each task. Also, indicate the time sequence the tasks must be performed in by writing a "1" in the "sequence" column next to all tasks that must be performed first, a "2" next to the tasks that must be performed second, etc. the duration is an estimate of how long the task will take to complete. Please give a real-time estimate of the duration. By "real-time", we mean the best estimate of time needed to accomplish a task in the real world (not the simulated world of DDD).

Sequence	Tasks to perform	Who will perform task	Necessary resources	Duration

Sequence	Tasks to perform	Who will perform task	Necessary resources	Duration

SYNCHRONIZATION AND COORDINATION CHART FOR TASKS TO COMPLETE THE MISSION

As a team, prepare a synchronization chart either graphical or written (or a PERT chart) of all the tasks that are necessary to perform the mission successfully. The figure is an example of a graphical chart. Tasks that must be performed synchronously should be depicted at the same level or tier as Tasks 2a and 2b of the example. If two or more nodes must coordinate to accomplish a task, indicate this by writing the coordinating nodes in the task bubble, as in Task 3 of the example.



<u>Please sketch or write out your synchronization and coordination chart below:</u>

Who will be coordinating the most with whom? What Tasks will require the most coordination?

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